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ORIGINAL ARTICLE: PALEOPATHOLOGY

Anthropological analyses of the Modern era-mummified human remains discovered in the Santa Maria del Monte sanctuary, Varese province, Italy

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Abstract. Northeastern Italy preserves, although rarely, some naturally mummified remains from medieval and modern times. This study considers the remains from the province of Varese, with particular attention to those found in 2001 in a hypogeal burial chamber in the Santa Maria del Monte sanctuary in Varese, Lombardy. The materials, analyzed with classical methods of physical anthropology, consist of one head, one arm with the forearm, one forearm with the hand, a hand, a foot, and a lower limb with the foot. The analyses have allowed us to acquire new data regarding the use of funerary spaces during the medieval and modern ages, regarding the treatment of the body of the deceased and their alleged health status. Finally, the work helped in planning the subsequent analyses, to acquire a holistic view of all the variables of the bioarchaeological context.

Key words: mummy; taphonomy; curation; Italy

1. Introduction

1.1 Natural mummies of the Varese province, Italy

Among the human remains from the Varese province, there are some which are mummified. The mummy preserved at the Civic Archaeological Museum of Villa Mirabello in Varese is well known. It is the body of a subject of 11±2.5 years of age who died probably during the Modern era, of unknown origin, found inside a wooden box in the Museum's deposits. Presumably, the mummy was subjected to radiological analysis during the 1970s by some local physicians, although documents to prove this have not been found (1). In 1985, the Institute of Pathological Anatomy and Histology of the University of Pisa performed anthropological, radiological, and paleopathological analyses of the mummy (2). Moreover, in 2001 some Modern age mummified human remains were found in a crypt of Santa Maria del Monte sanctuary, already known for its funerary evidence (Figure 1) (3).

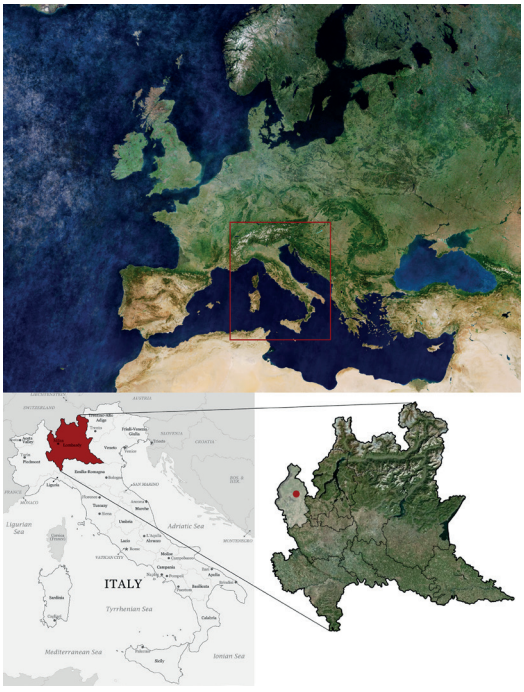

Figure 1. The Santa Maria del Monte sanctuary is located in Varese, Lombardy, in the north-western part of Italy

This article presents the preliminary results of the radiological, anthropological, and paleopathological analyses carried out on the remains from the Sanctuary of Santa Maria del Monte to identify future plans and research strategies reserved for the mummified remains of the Varese province.

1.2 Santa Maria del Monte – Archaeological framework

In 2001, the excavation carried out by the Soprintendenza Belle Arti e Paesaggio in Lombardy for the construction of an elevator led to the demolition of a wall and the discovery of a funerary hypogeal site in the lower layers of the sanctuary complex (4). The removal of the wall structure, which closed the door on the final stretch of the portico, revealed an underground environment leaning directly against the rock and located on the external adjacency of the southern foundation wall of the church, dating back to the Romanesque period. The funerary structures inside the crypt compartment (L-shaped, 3x5 m) demonstrated continuous use over time in the sanctuary. The oldest phases are testified by four tombs, probably belonging to some clergy members, placed under the pavement. Two anthropomorphic ones are close to the northwest wall, while the third tomb is east of the hypogeum compartment, and only the perimeter of the fourth is preserved. All these tombs contained skeletonized remains and grave goods, including a bronze coin with the Visconti viper. From the end of the 15th century, the crypt was used as a burial place. Over more than 300 years, the crypt has housed the remains of dozens of subjects wrapped in simple shrouds, superimposed on each other and sometimes separated by layers of quicklime. The first phase of the archaeological investigation focused on removing skeletal material in the hypogeal chamber. Inside this common ossuary the mummified remains of a head, a right hand, a foot, and two left arms were also found.

2. Materials and methods

2.1 Materials

The sample under analysis consists of one head, one arm with a forearm, one forearm with a hand, one hand, one foot, and the lower portion of a leg with a foot (Figure 2 a-f), found in the hypogeal sepulchral chamber of Santa Maria del Monte sanctuary. The state of conservation of the finds is variable; in fact, we identified well-preserved areas and others with soft tissue loss.

2.2 Methods

We analysed the partially mummified remains in 2021 at the Department of Biotechnology and Life Science of the University of Insubria. The study was based mainly on the external examination. Sex was determined based on the measurements of the long bones of the arms (5, 6), and morphologically with

Figure 2. The Santa Maria del Monte sanctuary sample under analysis consists of one head (a – lateral right, frontal, and lateral left view), one arm with a forearm (b – dorsal and palmar view), one forearm with a hand (c – lateral and medial view), one hand (d - dorsal and palmar view), one foot (e - palmar and dorsal view), and the lower portion of a leg with a foot (f – anterior, medial, posterior, and lateral view). Reference scale is 5 cm.

cranial features evaluation (7).

Skeletal age was estimated for non-adults via the osteometry of the leg's long bones, and with the diaphyseal and epiphyseal union stages (8-10), and for adults with a combined method of tooth eruption and development, along with tooth wear, and cranial suture closure (11-13). The teeth were recorded according to the FDI World Dental Federation notation (ISO 3950).

The radiological acquisition was used to verify and integrate the naked-eye morphological assessments.

Mummified remains were packed in an acid-free film to avoid contamination -from and to the outside- during the transportation and analysis phases. Acquisitions were carried out in the Gaetano and Piera Borghi clinic in Brebbia (Varese province). Conventional medical radiological equipment was used for X-ray and CT examinations (GE Healthcare Revolution - GSI 128 Layers). Imaging parameters were as follows: 100 kV, 80 mA. The slice thickness used was 0.625 mm for all the pieces, reconstructed at 3 mm (14). We edited the acquisitions with the software Mango (Research Imaging Institute, UTHSCSA), and Radiant DICOM 5.0.2 Viewer (Medixant, Poznan, Poland).

2.3 Ethical statement

To date, the Italian legislation does not require an ethics committee's opinion on analyzing archaeological human remains. The study received formal authorization from the Lombard Soprintendenza Archeologia Belle Arti e Paesaggio. All analyses were non-destructive to maintain the remains' integrity for possible future studies. The analyses were performed in compliance with the indications provided by the Istituto Centrale per l'Archeologia (ICA), the Istituto Centrale per il Catalogo e la Documentazione (ICCD), and according to the suggestions by Squires, Roberts, and Marquez-Grant (15).

3. Results

We analyzed one head, one arm with a forearm, one forearm with a hand, one hand, one foot, and the lower portion of a leg with a foot. We present the anatomical portions starting from the head and ending with the feet. All of the parts were evaluated as independent, verifying their possible belonging to a single subject in the discussion section in which the minimum number is estimated (see below).

Head

The subject (Figure 2 a) is a young adult male. As regards skeletal age, the skull does not present synostosis of cranial sutures, and the degree of development and eruption of the third molar of the right maxilla help to better define skeletal age. Regarding skeletal sex, the left supraorbital margin is rather rounded, the zygomatic arch exceeds, albeit for a short distance, the acoustic meatus both on the right and left side, the mastoid process is voluminous and verticalized, and, finally, the nuchal crest is marked. The gonial angle inclination is very close to the right angle, with slight eversion, and the medial surface is with slight bony ridges in the sagittal direction, typical of the pterygoid tuberosity. Out of the different non-metric characters, the left supraorbital *foramen*, the left epipteric (Wormian) bone, and the right condyloid canal are visible. These features allowed us to identify the subject as a probable male.

The articular surfaces of the occipital condyles show a dark, blackish coloration, probably due to the partial preservation of the cartilage. The skin covers the splanchnocranium except for the supraorbital margin, part of the left zygomatic bone and the mandibular angle, the body, the branch, the coronoid process, and the right and left condyle. The neurocranium retains only a small part of the skin covering the right frontal portion. The nose and the upper lip are preserved, despite being flattened, and the nasal incision, and the anterior nasal spine are well recognized. Appreciable are the fibers of muscle tissue; in particular, the right orbit is partially obliterated by what remains of the eyelid tissue and the corrugator muscle of the eyebrow. There is no hair, either attributable to the beard or the hair. Finally, it was possible to identify a slight bony swelling with a rough appearance inside the nasal cavity.

Out of the 32 teeth present in adult individuals, fourteen are *in situ* (ISO 3950: 16-17-18-22-23-24-25-26-27-33-34-35-37-46), seventeen were lost *post-mortem* (ISO 3950: 11-12-13-14-15-21-28-31-32-36-41-42-43-44-45-47-48), and one has not

erupted (ISO 3950: 38). M3, right upper third molar (ISO 3950: 18), is not yet erupted and is still in formation. Moreover, hypoplasia of the enamel with a concentration of pitting on the crown at the lingual level is noted.

M2, right upper second molar (ISO 3950: 17), is affected by small carious lesions distributed on the crown and near the collar at the buccal level and on the occlusal surface at the grooves. In the mesial and distal interproximal position on the crown, at the collar level, there is a minimal presence of calculus.

M1, right upper first molar right (ISO 3950: 23), has superficial caries that has not affected the enamel in the distal interproximal position and a minimal presence of calculus in the buccal interproximal position.

M2 left lower second molar (ISO 3950: 37), has destructive caries, extended in-depth, that has affected the enamel, dentin, and pulp, significantly compromising the integrity of the crown.

The alveolar bone of M2, the right lower second molar (ISO 3950: 47), is porous.

M1, right lower first molar (ISO 3950: 46), completely lacks the crown because this is destroyed by caries that extends to the root. Also, here the alveolar bone, mesially, presents an abnormal porosity. No dental element has a pathological alveolar retraction.

Forearm and hand

The remains (Figure 2 b) belong to a probable adult male subject. Indeed, the maximum radial head diameter suggests a probable male sex (24,7 mm) and the complete skeletal development of the bones is compatible with that of at least an adult subject.

There are, in anatomical connection, the radius, the ulna, and the hand, with the latter lacking the distal phalanx of the third and fourth metacarpals, and the intermediate and distal phalanx of the fifth metacarpus. The first metacarpal is no longer in connection with the trapezoid and the proximal phalanx, and the proximal phalanx with the intermediate phalanx of the third metacarpus. However, none of these bones are isolated as they are connected to the other hand bones through the skin. Anomalous is the position of the proximal and distal phalanx of the first metacarpal because they are rather verticalized. Finally, we detected macro-porosity and marginal lipping of the distal articular surface of the ulna.

The skin has good preservation of the surface. It covers almost exclusively the dorsal part continuing even beyond the radius and ulna at the elbow level despite the absence of the humerus. From the shape assumed, it is conceivable that the individual was buried with his arms bent at the level of the pelvis and with his hands placed one above the other, given the inclination of the fingers. Anteriorly, however, one can see the ligamentous and tendon fibers. The nails are entirely missing. Paleopathological analysis carried out at the macroscopic level showed no pathological signs.

Arm and forearm

The remains belong to a probable adult female (Figure 2 c). The osteometric analysis carried out on the humeral head suggest the female sex (vertical diameter = 38,2 mm). Skeletal maturity proves at least the adult age of the subject.

The humerus, radius, and ulna are in anatomical connection. The district is only partially skeletonized and cortical bone tissue is well preserved and does not present any taphonomic damage. Humeral head and a short stretch of its distal diaphysis is exposed. As regards radius, and ulna, only a distal portion of the diaphysis and the articular surfaces are exposed, specifically parts of the radius of the articular facet with the lunate and the scaphoid and the styloid process, and the articular circumference and the styloid process of the ulna.

The skin has no holes or lesions attributable to insect activities. However, the presence of possible fungal activity is noted. Below the skin, partly adhered to the diaphyses, both ligamentous and tendon fibers are well preserved and visible. The paleopathological analysis has highlighted, in the ulna, the results of an osteolytic activity in correspondence with the articular surface of the head, whose margins are slightly hemmed.

Hand

The right hand (Figure 2 d) belongs with certainty to an adult individual for the complete ossification of the distal extremity, that is, of the head of the metacarpals (second quarter) and of the proximal extremity of the first metacarpus, of which, however, it is not possible to establish the age at death. It is equally difficult

to determine whether it is a male or female individual because the bones of the hand do not belong to a diagnostic district in this sense.

The brown skin, present almost exclusively on the palm, is not well preserved and does not show folds, and under it, it is possible to observe parts of the muscles and ligamentous structures. There are post-mortal damages, such as sub-circular holes. The skeletonized parts, on the contrary, are well preserved. They do not have any particular color and are only partially absent. Out of the eight elements that make up the carpus, only the pisiform of the proximal row, the capitate, and the trapezoid of the distal row are present, while the proximal, intermediate, and distal phalanges of the second metacarpus, intermediate and distal of the third metacarpal are missing. The bones are well articulated except for the proximal phalanx of the thumb at the level of its base, which remains connected to the rest of the hand through the skin of the palm. No pathological changes are evident at the macroscopic level.

Leg and foot

The lower limb (Figure 2 e) pertains to a non-adult individual with an age at death of 4-4,5 years. The right tibia and fibula, the tarsus, and the metatarsal bones are in anatomical connection. All phalanges (14) and distal epiphyses of the metatarsals (from second to fifth), proximal tibia, and fibula are missing. The skin is well preserved, covering the entire calcaneus and metatarsal part of the foot and the distal portions of the diaphyses of the tibia and fibula on the lateral side, highlighting the underlying structures of tendons, ligaments, and muscles on the medial side. Here, the skin does not appear relaxed but is raised and crumpled and the foot appears distally flexed. Within the calcaneus, there is lack of substance and density in correspondence to some holes (Figure 5 b 1, II).

Foot

The left foot (Figure 2 f) belongs to an adult individual due to the complete ossification of the distal parts of the metatarsals (second – fourth) and of the proximal extremity of the first metatarsal, of which it is impossible to establish the age at death and difficult to attribute to a male or female individual. The skin covers the dorsal part except for the entire first metatarsal, the distal parts of the third, fourth, and fifth metatarsals, and the proximal phalanx of the big toe and the plantar part, leaving all the metacarpals exposed except the heads. Several signs of eburnation are visible in this area and, finally, the synostosis between the medial and distal phalanx of the first metatarsal bone can be seen. Small circular and subcircular holes are visible, which allow a glimpse of muscle and ligament tissues. The skeletonized parts are well preserved and articulated; all the bones of the tarsus, the distal phalanx of the big

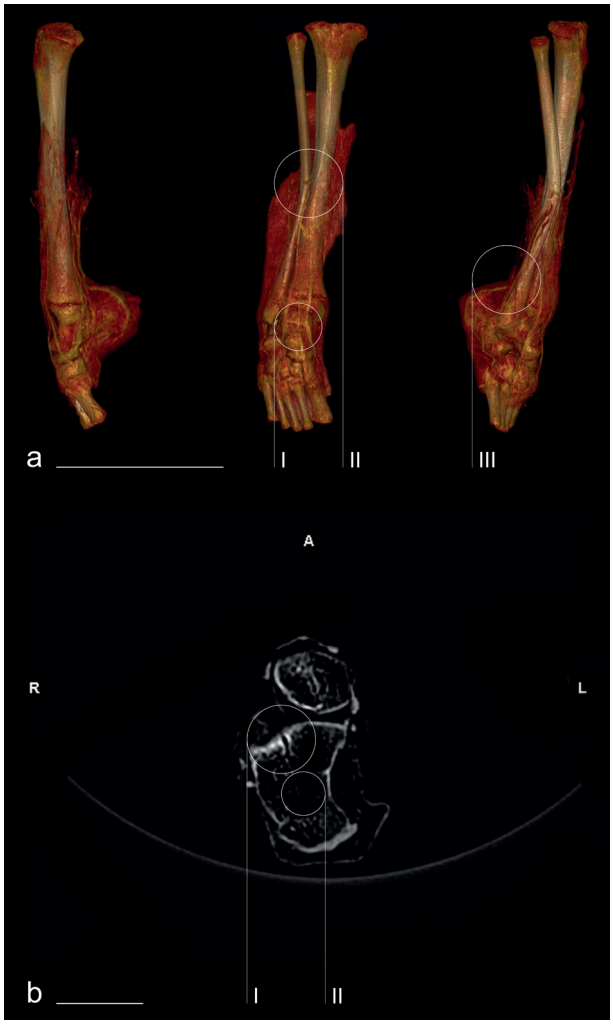

Figure 5. 3D model of non adult right leg (medial, anterior and lateral view); I) the Dorsal ligaments are visible under the derma; II) A possible post mortem fracture is found in the middle diaphysis; III) Plantar flexion of the leg. b) TC acquisition of the talus and calcaneus of the non adult subject; I) Holes in the cortical bone are surrounded by dense and thicker bone tissue; II) Lack of substance in the calcaneus.

toe, and the distal phalanx of the second metatarsal are missing. The nails are absent except for that of the fifth metatarsal. From a pathological point of view, a lateral deviation of the big toe is noted.

4. Discussion

The morphological analysis, integrated by the radiological one (16) allows us to verify and integrate the information useful for determining the sex and age at death of the subjects on mummified human remains (17). We estimate a minimum number of three subjects: one adult male and one female, as well as one non-adult of undetermined sex (Table 1).

We are faced with a sample that is not homogeneous either by age at death or gender. Therefore, anthropological analysis has allowed us to verify that there was no selected use of the hypogeum of Santa Maria del Monte as a funerary space.

From a taphonomic point of view, some considerations are possible (18). The mummified remains analyzed here were found commingled with other totally skeletonized ones. Unfortunately, it was not possible to verify the possible belonging of the skeletonized remains to the studied subjects, and therefore it was not possible to verify whether the remains at our disposal pertained to bodies undergoing partial skeletonization. What we can see, however, is partial mummification and different levels of tissue preservation even within the same anatomical portion (Figures 3 a I, II, b I, II,4 c, d I). The absence of well-preserved mummified bodies and the presence, on the contrary, of mummified body portions showing different degrees of preservation of the soft tissue allow us to hypothesize a natural process of mummification, thanks to favorable conservation micro-environments (19, 20).

The position that the skin and some limbs probably maintained during mummification can be useful for acquiring some data on the context (21). Emblematic in this sense is the analyzed head and in particular the skin of the nose and lips (Figure 2 a). In fact, it is possible to notice how the upper portion of the lip and

Table 1. Anatomic portion, side, sex and age of the human mummified remains of Santa Maria del Monte sanctuary.

Anatomic portion	Side	Sex	Age
Head	None	Male	20-25
Arm and forearm	Left	Female	>20
Forearm and hand	Left	Male	>20
Hand	Right	/	>20
Leg and foot	Right	/	4-4,5
Foot	Left	/	>20

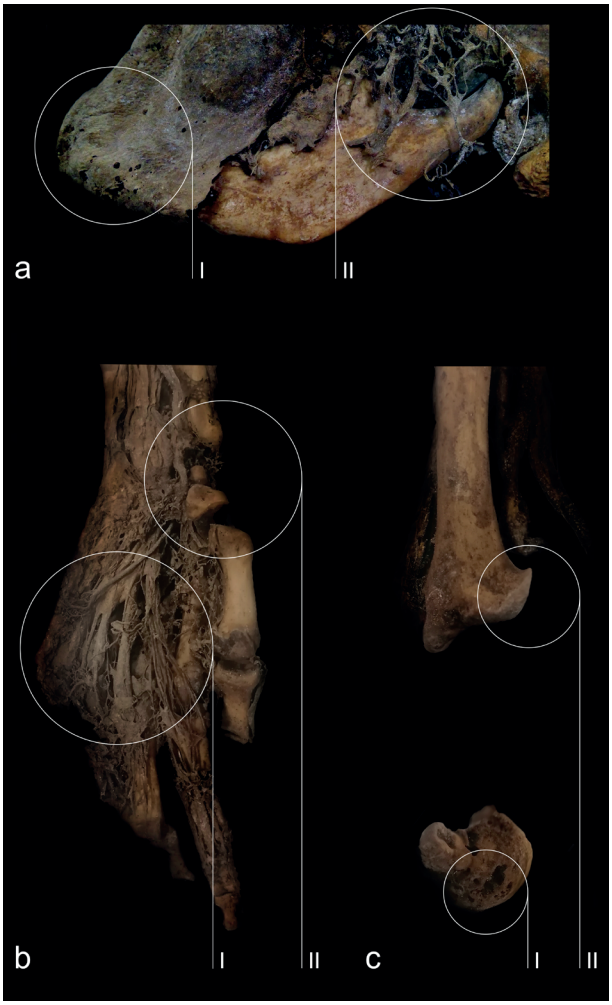

Figure 3. a) Different preservation of the head's soft tissues; I) Rounded holes (1-2 mm) in the skin of the chin may be related to entomofaunal activity; II) Partial preservation of the lateral ligament and masseter muscle. b) Different preservation of the right hand's soft tissue; I) Poor conservation of the lumbrical muscles and good condition of the ligaments of the superficial flexor muscles; II) No preservation of muscles related to thumb movement. c) Right radius and ulna; I) Macroporosity of the distal articular surface; II) Marginal lipping of the articular surface with radium.

the nose are oriented upwards. This is probably due either to the mummification conditions of the body or to the taphonomic events that occurred following mummification (22). On the one hand, in fact, it is possible that the face underwent mummification in contact with a hard and flat surface. On the other hand, it is possible that a change in the anatomical location of the tissues had occurred following mummification, due to the humidity of the tissues or their rehydration, and their subsequent contact with a flat surface. In the case of the leg of a non-adult, this allows us to verify the presence of a shroud around the bodies. In fact, the foot presents a strong plantar flexion, so much so that the skin at the heel level appears overabundant and wrinkled (Figures 4 b I, 5 a III). This, combined with the fragment of modest fabric preserved at the level of the tibio-patellar ligament, allows us to hypothesize the presence of a shroud that forced the body of the deceased into an unnatural position (Figure 4 a I). Finally, as regards the arm and the forearm, the assumed position suggests a deposition of the deceased with his arms bent over the abdomen.

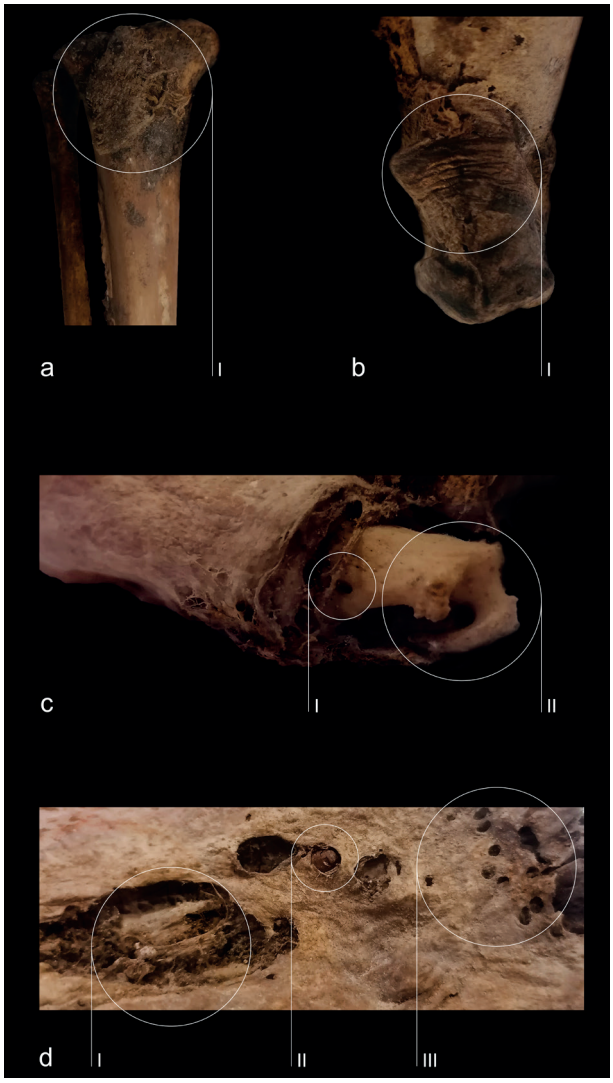

Figure 4. a) Proximal tibia and fibula; I) Fabric preserved at the level of the tibio-patellar ligament; b) Distal portion of the leg. I) Plantar flexion of the leg; c) Different preservation of the left feet tissues; I) Lacking of soft tissues in the distal portion; II) compression fracture of the proximal interphalangeal joint of the first metatarsal. d) Different preservation of the left feet tissues; I) derma is lacking and the ligaments of the feet are visible; II) The activity of the entomofauna is attested by a puparium (I) and some round holes in the derma (II).

On some of the anatomical parts, some round and ovoid holes in the dermis are observed. These holes can be traced back to the activity of the entomofauna that acted in the context (Figures 3 a I, 4 d I, II). Other biological forms, such as fungi, have been found in the sample. The latter, in particular, could be linked to the environment in which they were found, which must have undergone cyclical variations in humidity, sometimes favorable to the development of mycelia.

From a pathological point of view, some alveolar pathologies affecting the posterior portion of the mandible have been recorded, probably to be referred to an ongoing infection in the adult male (23). The poor health of the subject's oral cavity is also indicative of the *intra vitam* loss of some elements and the abundant number of caries present, in some cases destructive. The same subject also presents an interesting anatomical variant, a small epipteric bone (24), which articulates with the frontal, the sphenoid, the temporal, and the parietal bones. The epipteric bone is trapezoidal in shape and measures 9.6 mm on the frontal side, 16.7 mm on the sphenoid one, 21.7 mm on the temporal side, and 13.2 mm on the parietal one. On the right side, the epipteric bone invades the region of the ali-sphenoid. Finally, the slight bony swelling with a rough appearance inside the nasal cavity may be associated with pneumatization of the middle turbinate, a pathological condition known as Concha Bullosa and already known within the osteological record from the province of Varese (25, 26). Although the debate on this evidence has concluded for an epigenetic trait

(27, 28), recent clinical and paleopathological literature tends to be more careful about these formations, of connective or membranous origin, which develop from complementary ossification centers, sometimes appearing in the pteric fontanelle (29).

Of interest are also the evidence of eburnation affecting the proximal metatarsal joints, probably due to a compression fracture of the proximal interphalangeal joint of the first metatarsal, which led to the subsequent fusion of the distal phalanx in a perpendicular position (Figure 4 c I, II) (30). Moreover, the porous bone detected in the medial diapyhseal surface of the tibia could be linked to a metabolic disease, among other possibilities due to its broad etiology (31, 32). Finally, the macro-porosity and the marginal lipping detected on the ulna of one subject may possibly be linked to arthritic processes due to the repeated use of the joint or to the age of the individual (Figure 3 c I, II).

5. Conclusions

The study made it possible to acquire new knowledge on the osteological cultural heritage of the province of Varese (33-35). The analysis also allowed us to map the deterioration of the remains, an operation that is useful in predictive terms for their correct conservation for future analyses (36, 37). Further investigations of the mummified remains will be carried out in the next future (38). Radiocarbon analyses will certainly help in understanding their context and its use. Furthermore, to verify and integrate the data in our possession, it will be useful to carry out more lab analyses like the toxicological, chemical, parasitological, and molecular ones on the mummies, in order to acquire new information on their history, health, habits and their possible origin (39-41). Moreover, the entomological analysis will also be of primary importance allowing us to verify the species present in the context and to acquire data useful for understanding the decomposition environments and their possible variations over time (42-44).

Once again, mummified remains prove to be an extensive source of data useful for understanding our past and the mortuary treatment of the body reserved for these individuals.

Author contributions: All authors declare no competing interests.

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