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A child and his fate: tuberculosis, perimortem trauma and mummification

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ABSTRACT: A male child, sitting, 7 years, circumferential deformation, skin marked by coiled fibers, nostril plugs, consistent with Aymara practices was CT scanned. Puppae in the skin suggest exposition of the body previous to the funeral. Dark brown color at the skin suggest blood perfusion. A broken area at the right frontal with the skin partially inside is suggestive of perimortem trauma. There were no bone debris inside the skull and the CT images show two confluent fractures defined by radiating lines extending beyond the missing bone surface. The right eyeball is projected out, the tongue is outside the mouth, the meninges are pushed to the left, suggesting strong edema after trauma. The skin around the wound is also brown suggestive of blood deposition. The violent wound is possibly the cause of death. Calcified lesions at the right lung and Harris lines are consistent with Primary Complex of tuberculosis. The funeral of this child, apparently inside a Chulpa, at the Altiplano, point not a violent not a ritual death.

KEYWORDS: Perú; Aymara; Tuberculosis; perimortem trauma; CT scan.

PALABRAS CLAVE: Perú; Aymara; Tuberculosis; trauma perimortem; tomografía computerizada.

Introduction

Two Aymara bundles, a male child and an adult from Titicaca region, Bolivia, were donated by Frederico Puga Boene, former director of the Valparaiso Museum, to the National Museum, Brazil. The donation was accepted by Dr. Demétrio Lastarria, Council of Chile in Brazil. The acceptance document is in the Atas do Conselho Administrativo #1, dated from 4 of March, 1881. The two prehistoric peruvian bundles were brought to light during the new curatorial program, and both are now part of the present exhibition, in the Room of the Mummy.

This paper is about the mummified body of the child, collection #8317 (Fig. 1). That well preserved body was CT scanned and analysed for the first time in 2006. No artifacts or dressing were associated to this mummy, but all over the skin surface it is possible to see the impressions of a coiled basket made of

twisted fibers, possibly *titora*. Although there is no contextual information about the archaeological site, the former identification in the donation document indicates this is a prehistoric Aymara mummy, being possible that this body came from a *chulpa*, a kind of stone tomb where the important Aymara families were buried.

Discoloring of left legs and trunk suggests that the body fluids and/or blood were concentrated along this side of the body, suggesting that the position of the body was laying on his left immediately after death. Flattening of the sacral area indicates that the burial position was sitting, what is consistent with the funeral practices in the Andean area. The upper and lower limbs are flexed but not symmetrical. The lower limbs are parallel to each other, the knees are positioned to the right side of the body and the ankles to the left, the feet are strongly flexed pointing upward, the right toe was

fixed in abduction. The arms are parallel to the trunk, the left and right forearms are parallel, respectively, to the thighs and to the legs. The hands are in front of the body and the fingers are extended. The backbone is also strongly flexed, and the head is bending to the right, facing forward. The body is close to the fetal position. Perhaps the position of the body was partially fixed before the mummification, depending on the way the boy was laying dead, but the corpse was certainly prepared to a funeral.

Small apertures can be seen all over the skin, possibly the consequence of the gases phase of decomposition. Depending on the funeral ceremonies and time elapse between the death and the burial, decomposition may have started before the mummification processes. Inside the skin apertures it is possible to find young insects and pupae, possibly associated to the decomposition waves. Remains of recent colonizers such as dermestides, spiders, and termites were also found

in the mummified body. Small perforations of the skin and bones point to later preservation problems, perhaps in the Museum repositories. Insect damage also destroyed most of the hair that is scarce and shortened by post mortem damage, but still showing a few nits. Future entomological analysis is expected to clear any possible relation between the insects and the conditions of the body immediately after death, after burial and after mummification.

A postmortem fracture of the neck separated the head from the body. The fresh and clear surface of the fracture confirms it is recent, possibly caused by inadequate storage and/or manipulation. The front part of the maxillary bones was also broken, and some of the incisor teeth are missing. The skin and the frontal bone are opened at the right side of the head, just above the right eye, the damage partially affecting the orbit roof and the eye. The rotten skin is folding inside the fracture. A brown discoloring reminds hemosiderine deposition. Through the fractured bones and skin is possible to see inside the skull. Contrary to the previous damages, this fracture has no fresh borders and it is possibly peri-mortem.

The original position of the head was bending to the right and front of the body, facing forward and in contact with the knees. The preserved nostrils are strongly plugged with vegetal fibers, the plugs expanded the nostrils specially at the left side. The protruding tongue comes out of the half opened mouth and teeth, the lips are deviated up and right. The eyelids are opened and the eyes are preserved; the nasal cartilage is compressed, possibly by the wrappings. The tower like head indicates intentional modification of the skull. The morphological appearance is consistent with the annular modification seen in the Titicaca region where the mummy comes from (Fig. 1).



FIGURE 1. Mummified body of a 7 years old Aymara boy (#8317) curated in the National Museum collection, Rio de Janeiro, Brazil (Photo: Karl Reinhard)

Methodology

After the examination of the surface of the body, and sampling for further laboratory examination, the mummy was CT scanned. Good slices of the whole body were reconstructed in transverse, saggital and frontal planes. 3D reconstructions of bones, head and the whole mummified body, as well as Maximum Intensity Projection (MIP) were also provided. The images helped to identify the anatomical details, to estimate

age and to survey the internal organs. Future invasive analysis is planned to sample the organs inside with the help of the CT images.

Age estimation was based on the analysis of the long bones (osteogenesis, maximum bone length), hands (osteogenesis) and teeth (dentogenesis) (Buikstra & Ubelaker, 1994) Both, the direct examination of the mummy and the radiological images, were considered here (Aufderheide & Rodríguez Martín, 1998; Cockburn, Cockburn & Reyman, 1998). Paleopathological examination of the bones considered not only their outer contour, but also inner structures, according to the literature (Resnick, 1996; Ortner & Putschar, 1997). Well preserved lungs and meninges, among other organs, were helpful to identify pathologic conditions. Post depositional processes and the burial position of the deceased were also confirmed by the position of the internal organs.

Results

The presence of the viscera and the absence of skin incision indicates no evisceration. The good preservation is suggestive of natural mummification, or intentional natural mummification (Cockburn, Cockburn & Reyman, 1998). The thorax and the

abdominal cavities remain perfect without collapsing, the contracted diaphragm still separating them. The lungs in both sides of the thorax had retracted caudally and to the mediastinum, not dorsally because the individual was buried in the sitting position. The bronchial silhouettes are quite evident in the spongy-like pulmonary parenchyma. The pericardial sac can also be seen at the frontal left chest, but the heart muscle is decomposed, possibly because of its strong enzymatic content (Aufderheide & Rodríguez Martín, 1998). The intestinal tract collapsed inside the small pelvis. Loops of the bowel are suspended or settled in the lower pelvis, due to the effects of gravity. Amorphous contents inside the guts are suggestive of residual food and/or coprolites. Organs like the liver, the kidneys and the spleen could not be seen. Muscles, cartilages and ligaments are also well preserved. The skeleton is fully articulated and the only missing bone is the fifth cervical vertebra, possibly lost after the post-mortem fracture. The mummy is well preserved with no sign of significant insect damage internally. The preservation of organs and membranes is so good that mummification possibly did not lasted a long time after burial. The dry and cold climate of the Altiplano as well as the architecture of a *chulpa* possibly contributed to the good preservation of this small body.

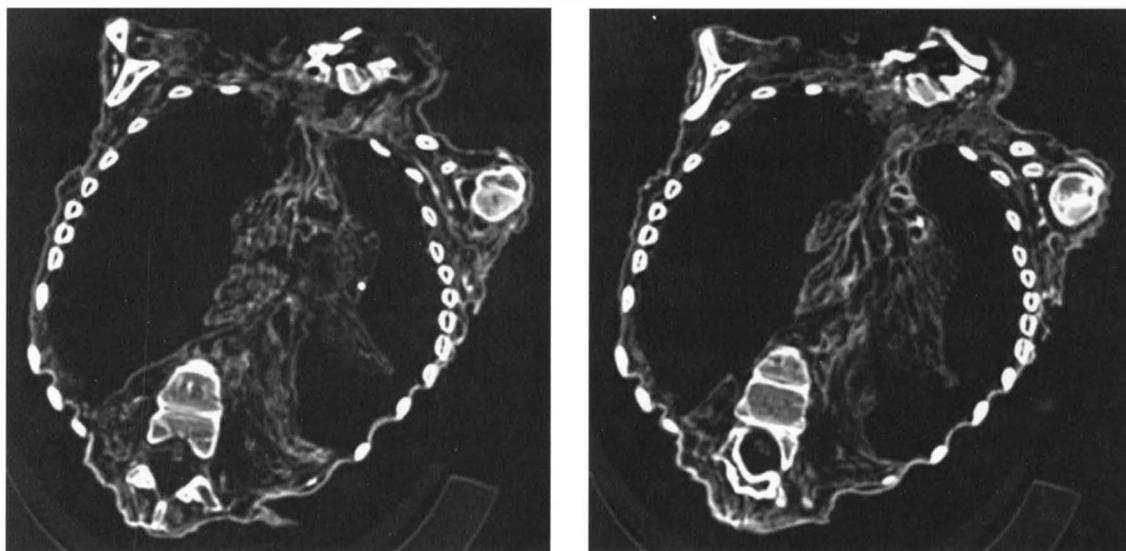


FIGURE 2. CT scan slices of the right lung of the Aymara boy. Calcified lesions consistent with tuberculosis (Primary Complex) in the parenchyma and mediastinum

The well preserved genitalia confirm this is the mummy of a boy. The scrotum and the penis were clearly visible. His age was estimated in seven years old, because the first molars but not the canines were fully erupted. The length of the right tibia (19,0cm), femur (23,0cm) and radius (11,8cm) and their epiphysis morphological stage are consistent with the age of seven, as well as the hand osteogenesis. At least four irregularly spaced Harris' lines are seen in the femur and tibia, indicating important episodes of arrested growth in the few years of his infancy.

The lungs are clearly visible inside the chest. Two round silhouettes, with calcified density, measuring about one centimeter of diameter can be seen in saggital and transverse slices (Fig. 2). One of them is in the upper part of the right lung; the other one is close to the bronchial silhouette at the right hylum. Their position and morphology are respectively consistent with a calcified granuloma at the parenchyma of the right lung, and a bronchial linfonode. Both are indicative of Primary Complex of pulmonary tuberculosis, or Ghon Complex (Bloom, 1994). No other similar lesion was seen in the viscera or bones.

The direct examination of the head, as well as the 3D reconstruction (Fig. 3), confirmed the typical intentional shaping of the head so-called anular, or Aymara type (Munizaga, 1987). The right frontal bone shows a big area of missing bone and radiating fracture lines. The direct examination of the mummy revealed that the fracture had no fresh borders, and that the mummified skin of the head was firmly folded inside the fracture, suggesting the head was broken and the calotte debris were removed before the mummification process. Part of the skin is damaged or missing and the brownish discoloration suggests blood perfusion around the wound. The CT scan confirm fracture traces extending through the face (nasal bones and orbit roof). It was also possible to see that the fractured skull tables were beveled, confirming the perimortem fracture to be explained by a strike from outside of the skull. The fractured and dislocated bones are fixed by the mummification process. The right eye is more shrunken and depressed than the left one, and it was possibly dislocated by the trauma too. All the previous findings support the hypothesis that this trauma was probable cause of death.

The 3D reconstruction of the head (Fig. 3) confirms the polygonal contour of two confluent fractures, each one with radiated lines. The 3D

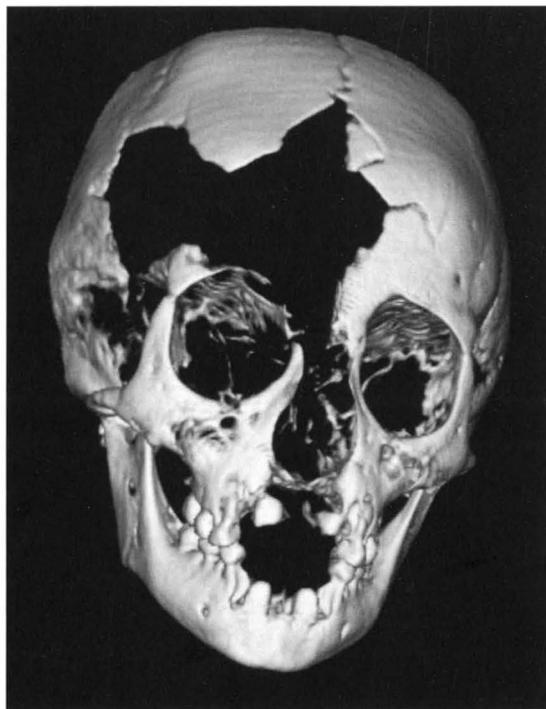


FIGURE 3. 3D image of the Aymara boy skull, notice the intentional annular shaping of the head and the fracture at the frontal bone

images confirm two points of impact about 4 cm far from each other. The first one is almost at the middle of the frontal bone; the second one is more close to the suture between the frontal and the right temporal bone. The CT slices showed no calotte fragments inside the skull. It was also possible to see that the middle, right and left meningeal membranes are preserved, and that mummification fixed them in asymmetric position, strongly dislocated to the left.

Discussion and Final Remarks

A boy of about 7 years old, with annular skull intentional modification was buried according to the cultural patterns of the Titicaca region. His body was naturally mummified and was very well preserved. Consistent with rapid mummification, the well preserved viscera are testimony of the burial position. They also contributed to paleopathologic diagnosis. Analysis of the skull also reveals aspects of culture possibly associated to the cause of death. This boy died early, but at seven years old he had survived the most crucial years of his infancy.

One of the risks of his time was pulmonary tuberculosis. The respiratory infection was endemic/epidemic in the Andes since prehistoric times (Roberts & Buikstra, 2003; Prat & Mendonça de Souza, 2003). The findings in this mummy are strongly suggestive of the healed signals of the Primary Complex of tuberculosis or Gohn. Harris lines in femur and tibia confirm physiological stress in some periods of his life. Like many other mummified bodies from the Andean area, tuberculosis is evident in this boy. However, tuberculosis was not the cause of death because the lesions are healed and there is no signal of secondary infection in his body. As most of the children he had a high chance to die before he was 5 years old. Harris lines call attention to episodic stress he recovered from during his infancy, one of them was the prime infection of tuberculosis.

This finding confirms that the pulmonary tuberculosis was present among South American prehistoric people, and that the epidemiologic, pathologic and clinical characteristics were close to the modern respiratory disease. Survival of infected children with healed and calcified lesions was possibly frequent in the ancient endemic areas, just like today. Epidemiological statistics show that 5 to 10% of the infected children do not recover spontaneously from the Prime Infection, 80% are symptomatic between 1 and 3 years old, and 100% are symptomatic before 5. Most of the Primary Infections are in fact acute episodes having no consequences.

The children who resist to the first contact with TB bacilli are temporally protected by immune response. That immunity disappear almost completely about 16 years old, when the risk of having a second infection episode increases again. Thus the existence of endemic TB is associated to the existence of resistant youngs and natural selection associated to the mortality of the fragile individuals in the very infancy. Although individuals as the child described here have latent bacilli in the healed lesions, epidemiological studies have proved that it is very rare that later clinical manifestations are caused by the activation of the old lesions, once after a few years the bacilli are not viable any more. Most people that present symptoms of tuberculosis many years after the Prime Infection had in fact a second infection (Bloom, 1994).

This mummified boy had also a big head fracture that probably caused his death. Acute

trauma, among other violent trauma, was also a daily risk for the Andean people. If trauma was the cause of the fracture, would it be accidental, or intentional? Some violent traumas may be accidental, when playing or practicing with weapons, chasing, or being accidentally caught in cross fire or an ambush. Aymara people were divided in warring states, until they were absorbed by the Inca. They were also known for their tactic of ambushing, and for the use of stone headed clubs, "bolas" and slings for fighting, instead of bow and arrow. Intentional as well as accidental violence could explain this fracture.

Violence casualties are not specific of the young male warriors. Studies concerning historical, ethnographic and archaeological cases (Bishop & Knüsel, 2005) call attention to the fact that during war 90% of deaths may be civilian non-warriors, including women and children. Violent death could also be associated to funerals of important people. Families, including children would be killed or buried alive in the *chulpas* (Tchopick, 1946). Either killed by accidental or intentional practice, his funeral was prepared. Maybe the study of the mummified insects will tell us more about the death and funeral.

The differential diagnosis for perimortem fracture may be difficult. In the case of this child, the suggestive blood staining of the skin reinforces the hypothesis of head injury before death. Position of the viscera inside the body confirms that the burial was in the sitting position, and the position of the head was bending right and forward. Because of that the meninges could not fall naturally to the left by the effect of gravity. The way the meninges were fixed is suggestive of an expansion inside the braincase, like a trauma causing encephalus edema pushing the brain and meninges to the left.

The head fractures in this mummified child point to a violent cause of death. It is possible that the head received a double impact. This could have been one strike with a weapon with two or more projecting impact surface, like a stellate war club or mace. Alternatively, it may be two distinct blows caused by "bolas" for instance. The first point of impact would be the more central to the frontal bone, causing radial fracture lines. The second impact caused a second group of radial fracture lines that crossed the previous ones. After the skull fragments were removed two confluent polygonal areas of missing bone could be seen. As no calotte fragments were inside the skull,

and the skin retracted inside the wound before the mummification started, it is also possible to propose that the calotte fragments were intentionally removed before the burial, what could be part of the preparation of the deceased.

Finally, it is noteworthy that after surviving the most critical years of his infancy the risk of death to

this boy was low. He had already survived childhood diseases, including tuberculosis primary infection. Violent death although considered unexpected for his age, would be one of the most probably causes of death for such a survivor. In this case, blunt force head trauma could have been caused by war, accident or sacrifice.

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