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A case of nonvenereal treponematosis in a pre-Hispanic adult from north-eastern Argentina

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Abstract

This article presents a case of treponemic disease in a skeleton of a female adult found at Los Tres Cerros 1 archaeological site (Upper Delta of Paraná River, Entre Ríos, Argentina). This site was occupied by hunter–gatherer–fisher groups that also practised horticulture during the Late Holocene (ca. 1227–560 years BP). A macroscopic description of bone lesions is complemented with data from X-rays and CT scans. Different types of lesions were observed in the left ulna, femora, right patella, tibiae, and fibulae. In addition, two remodelled depressions surrounded by bony thickening and porosities were found in the frontal bone. Some lesions registered in the skull were associated with *caries sicca*. In the differential diagnosis, chronic leg ulcers, Paget's disease, tuberculosis, leprosy, osteomyelitis, and treponematosis were considered. The analyses indicate that most of the injuries may be compatible with nonvenereal forms of treponematosis. Few cases of treponemic disease were recorded in Argentina's bioarchaeological collections of pre-Hispanic populations. Specifically, in the north-eastern region, two skeletons with treponematosis have so far been reported. The present study provides new evidence of treponematosis in the Delta of the Paraná River. Therefore, this case adds to the scant evidence of pre-Hispanic treponematosis that exists for these latitudes.

KEYWORDS

differential diagnosis, hunter–gatherer–fisher and horticulturist groups, Late Holocene, treponematosis, Upper Delta of Paraná River

1 | INTRODUCTION

Soon after the year 2000, systematic archaeological projects were initiated in the Paraná Delta, north-eastern Argentina (Bonomo, Politis & Gianotti, 2011; Nóbile, 2002). In addition to fieldwork, different lines of research, including bioarchaeology, began to be developed. The studies focused mainly on the description of the bone record, mortuary practices, and in specific cases, the analysis of paleodiets and pathologies (Bonomo, Scabuzzo, Politis, & Zucol, 2017; Cornero & Puche, 2007; Kozameh, Lopez, Testa, & Mazza, 2007; Mazza & Loponte, 2012; Ramos van Raap & Bonomo, 2016; Scabuzzo & Ramos van Raap, 2017), based both on human burial sites found in recent excavations and on the collections generated in the first half of the twentieth century (e.g., Lothrop, 1932; Torres, 1911). With regard to paleopathological studies in this area, few individuals with lesions of infectious aetiology were reported (Cornero & Puche, 2007; Kozameh et al., 2007; Torres, 1911).

The aim of this paper is to present a case of treponematosis in a skeleton of a female adult, in order to evaluate the importance of infectious diseases in hunter–gatherer–fisher and horticulturist groups from this area. This case adds to the scant evidence of pre-Hispanic treponematosis that exists in South America. Finally, these studies are part of the archaeological research that our group has been conducting in the area since 2006, to study the diversity of lifestyles of the pre-Hispanic populations in the Upper Delta of the Paraná River (Politis & Bonomo, 2012).

2 | SAMPLE AND METHODS

The skeleton analysed (hereafter LTC1-P4) comes from Los Tres Cerros 1 (LTC1) site (Victoria department, Entre Ríos province, Argentina; Figure 1). LTC1 is part of an archaeological locality that comprises three human-made earthen mounds. The site was occupied during the Late Holocene (between 1227 and 560 years BP) by hunter–gatherer–fisher groups that also practised horticulture (Politis, Bonomo, Castiñeira, & Blasi, 2011; Scabuzzo & Ramos van Raap, 2017). These groups are associated with Goya-Malabrigo archaeological entity (Politis & Bonomo, 2012). The hunter–gatherers and fishers who inhabited the alluvial plain of the Middle and Lower Paraná and Lower Uruguay Rivers from circa 2000 years BP until the 17th century are called Goya-Malabrigo by archaeologists (Ceruti, 2003). The Goya-Malabrigo archaeological entity (Ceruti, 2003; Politis & Bonomo, 2012) has distinctive settlement pattern, subsistence, and pottery. Their settlements consisted of different sorts of sites, and anthropogenic earth mounds (locally called *cerritos*) are the most visible feature. These mounds were used as living spaces as well as burial places, which included complex mortuary treatments in primary and secondary burials. They were also semipermanent villages. Subsistence was based on mammal hunting and fishing, and birds, reptiles, and freshwater mollusks were also exploited (Bastourre, 2014). More recent starch and phytolith analyses have demonstrated evidence of maize, beans, and squash in many prehispanic Goya-Malabrigo sites (Bonomo et al., 2011; Colobig, Sánchez, & Zucol, 2015). The Goya-Malabrigo archaeological entity (Ceruti, 2003; Politis & Bonomo, 2012) has distinctive pottery, with incised decorative designs and zoomorphic appendages. Truncated cone-shaped pottery pieces modelled with bird head appendages called *campanas* (bells) are also characteristic.

Several human inhumations have been found on LTC1 site, amounting to a minimum number of 35 individuals of both sexes and all age categories. The burial modalities are varied, including simple primary burials and simple and multiple funeral packages; bone accumulation and isolated bones were also recorded (Scabuzzo & Ramos van Raap, 2017).

Sex was determined from the morphological characteristics of the pelvis and skull (Acsádi & Nemeskéri, 1970; Buikstra & Ubelaker, 1994; Phenice, 1969). The age at death was estimated from the symphysis pubis (Todd, 1920 in Buikstra & Ubelaker, 1994). LTC1-P4 corresponds to a middle-aged adult female (aged 35–44 at death), found in flexed position in a primary inhumation. A radiocarbon dating of 801 ± 46 years uncal BP (665–796 cal years BP) was obtained (Scabuzzo, Ramos van Raap, Bonomo, & Politis, 2015). The skeleton is complete, and the bones have, in general, a good state of preservation and completeness.

The study of bone lesions was done by naked-eye macroscopic examination of the cortical surface and with a 10× stereomicroscope. Different characteristics were observed in order to describe the lesions: bone and side, affected section (proximal and distal epiphysis, proximal and distal metaphysis, and proximal, medial, and distal diaphysis), and affected surface (anterior, posterior, medial, and lateral). In addition, type of bone (woven, lamellar, or mixed) and external morphological changes were registered. In order to minimise intraobserver and interobserver error, the recording of these aspects was performed by each of the authors three times. A photographic registry of bone lesions was also carried out. Finally, image diagnosis of the lesions was performed by means of X-rays and CT scans.

FIGURE 1 Localisation of the site Los Tres Cerros 1 (Entre Ríos province, Argentina)

3 | PATHOLOGICAL DESCRIPTIONS

Pathological lesions in LTC1-P4 were surveyed in eight bones of the appendicular skeleton (Figure 2). The left ulna is the only bone of the upper limbs with bony lesions: The distal diaphysis presents a modified contour with enlarged appearance and bone reaction on the medial surface (Figure 3a). The right ulna does not present any type of bone anomaly.

In the lower limbs, the distal diaphyses of both femora are enlarged, due to a layer of bone integrated into the cortex. An active bone reaction was registered on the lateral surface of the right femur (Figure 3b). The right patella has woven and sclerotic bone formation, and the presence of a cavity stands out on the upper external surface (Figure 3c). None of the articular surfaces of the femur and the patella are affected, and no bone changes were observed.

Diagnostic imaging of the right tibia (Figure 4) showed some macroscopically salient details, along with others that were not visible to the naked eye. A distinguishing feature among them is a probable lytic lesion with diffused edges in the insertion of the *soleus*, which has small ossifications (Figure 4a). Furthermore, the diameter of the diaphysis enlarges in the distal half of the element, corresponding internally to a reduced medullary cavity due to a considerable growth of the cortical and trabecular bone (Figure 4b). On the posterior and lateral

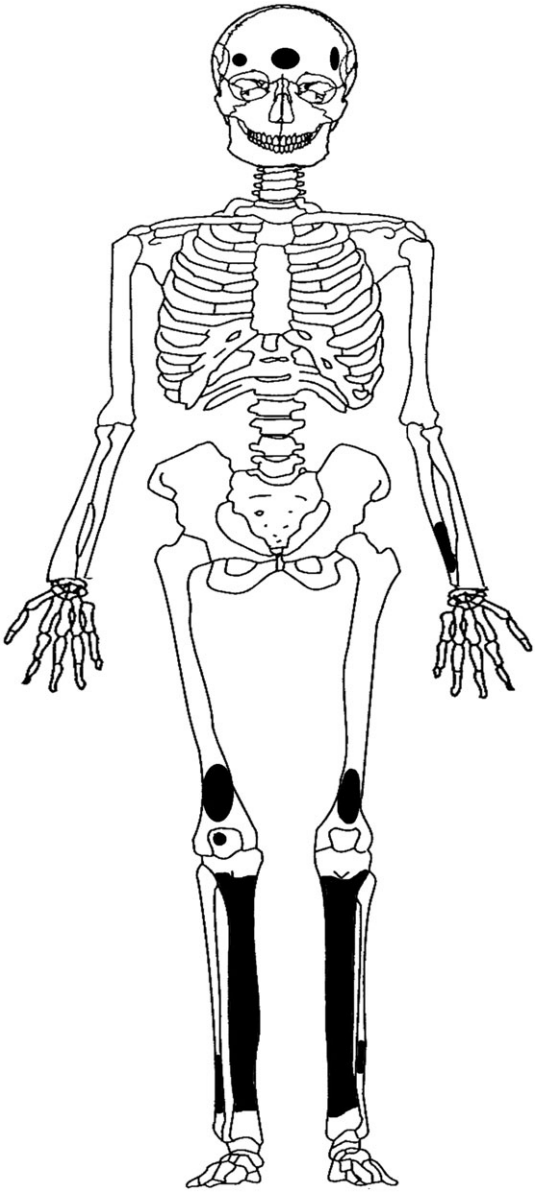

FIGURE 2 Representation of the skeleton with the locations (shaded) that were recorded lesions

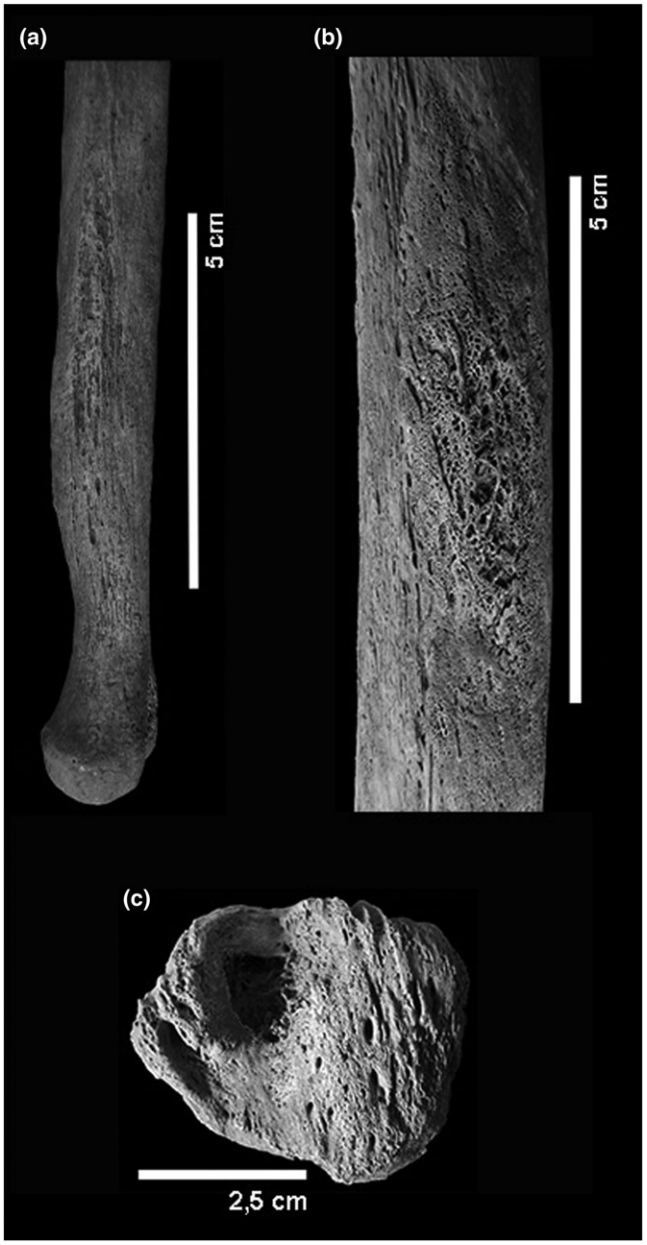

FIGURE 3 Lesions recorded in several leg bones: (a) distal diaphysis of the left ulna; (b) medial diaphysis of the right femur; (c) external surface of the right patella

surfaces of the distal diaphysis, a localised region giving an appearance of enlarged bone corresponds to a lytic lesion with a very well-defined edge in cortical tissue (Figure 4c). Finally, two possible striated nodes with a central cavitation (Hackett, 1976, pp. 93–97) were observed on the anterior crest (Figure 5) and the lateral surface of the distal diaphysis. The left tibia is also affected along its diaphysis, but with a greater presence of sclerotic bone than its contralateral. Towards the distal diaphysis, it presents modified morphology with increased outer diameter. In addition, both tibiae have vascular grooves (Wells, 1963) in the diaphysis. The right fibula is only affected in its distal half, with spiculated thickening of the periosteum on the medial surface (Figure 6a). The crest of the anterior side shows a thin layer of tissue on the cortex (Figure 6b). This was also recorded on the medial aspect of the midphysis of the left fibula. The rest of the fibula is not modified. None of the bones of the skeleton has compromised joint surfaces.

In the middle of the frontal bone of the cranial vault, we observed two adjacent depressions, which are similarly circular-ovoid shaped, remodelled, and surrounded by bony thickening (Figure 7a). One of the depressions presents a slight striation of the bony tissue. In addition, a lighter area and some pores are observed below these depressions and above the right orbit (Figure 7b). The same feature was recorded in the left part of the frontal bone (Figure 7c). The nasal region and the palate region do not present alterations.

Other slight skeletal changes were observed. Two granulomas were registered in the maxilla associated with first left premolar and molar (Dias & Tayles, 1997). These lesions may have been caused by exposure of the pulp chamber due to severe tooth wear in these teeth. In association with these periapical lesions, the left malar presents a small periosteal reaction with woven bone. Additionally, a symmetrical pair of linear enamel hypoplasias was observed in the mandibular

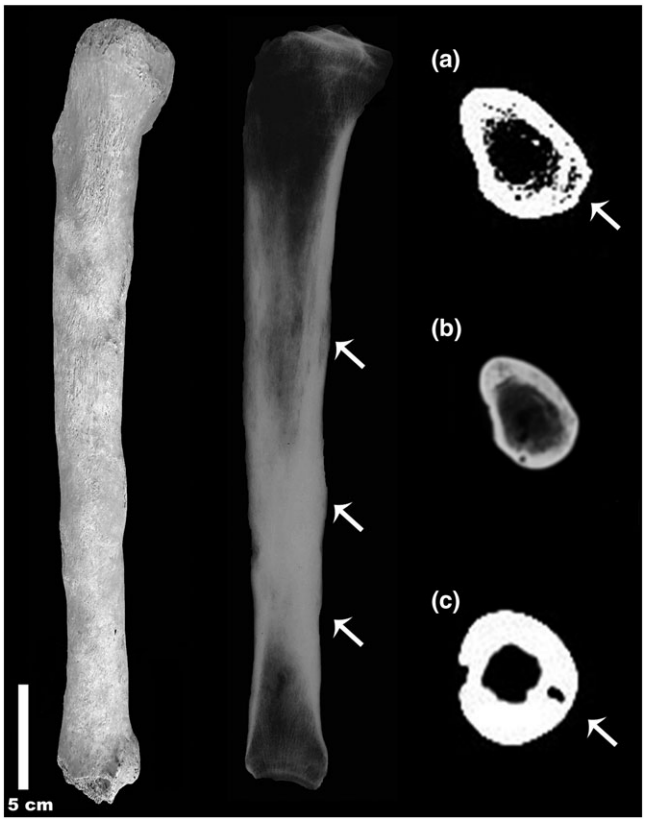

FIGURE 4 Images of X-rays and CT scans of the right tibia: (a) picture of medial surface; (b) lateral Rx; (c, I, II, and III) CT cross sections

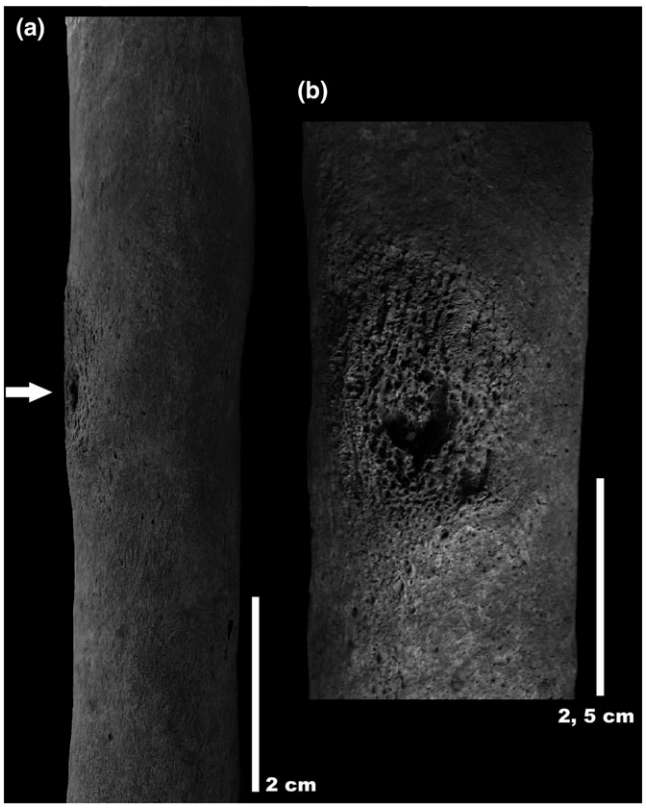

FIGURE 5 Striated node with a central cavitation in the medial diaphysis of right tibia: (a) profile view; (b) front view

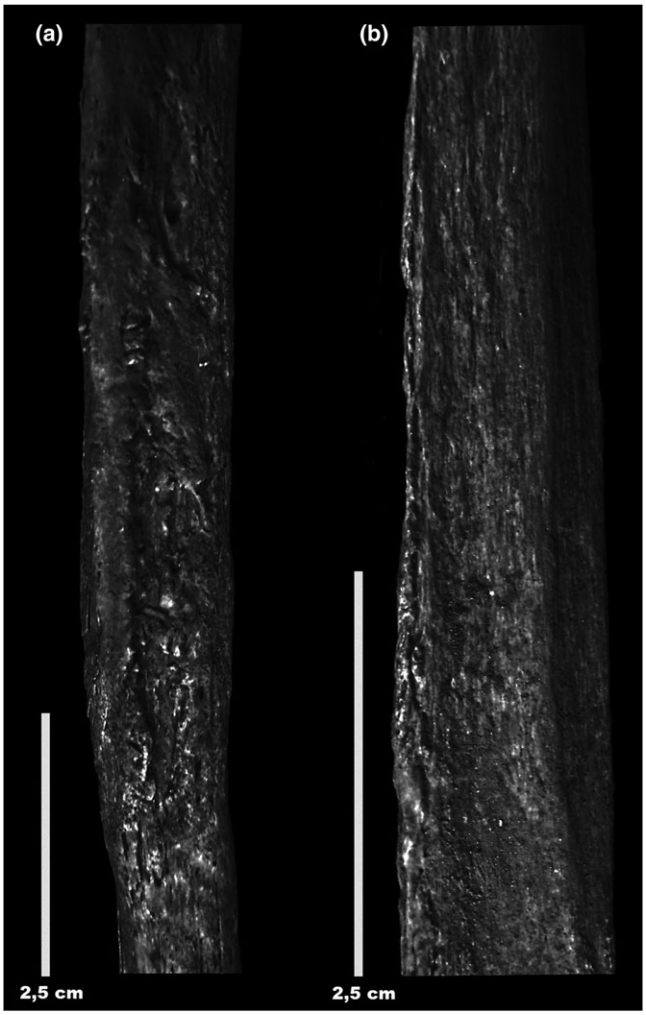

FIGURE 6 Bone reaction in right fibula: (a) medial diaphysis; (b) proximal diaphysis

canines; this defect occurred during childhood, between 3.1 and 3.6 years of age (Reid & Dean, 2000, 2006). In the vertebral column, marginal osteophytes and porosities were observed in seven vertebral bodies. In the first sacral vertebra, a hollow compatible with a Schmörl's node was recorded. Bone modifications were also observed in the enthesis: The right clavicle presents a cavity in the costoclavicular ligament insertion; the femurs have ossifications in the proximal epiphyses in the gluteal insertion; and the left calcaneus presents ossifications in the heel.

4 | DIFFERENTIAL DIAGNOSIS

In considering bone reactions in LTC1-P4, one aspect to be noted is the systemic nature of the lesions (affecting mostly bones of the lower limb). Another aspect is the bilaterality; the same types of lesions affected the same regions of the long bones of the legs. The specific characteristics of the reactions indicate that the individual suffered a bone infection. This infection was active at the time of death of the individual, given the presence of woven bone in some elements. However, zones with remodelled tissue were also recorded, denoting their long chronicity. Hence, different pathologies can be considered in the differential diagnosis.

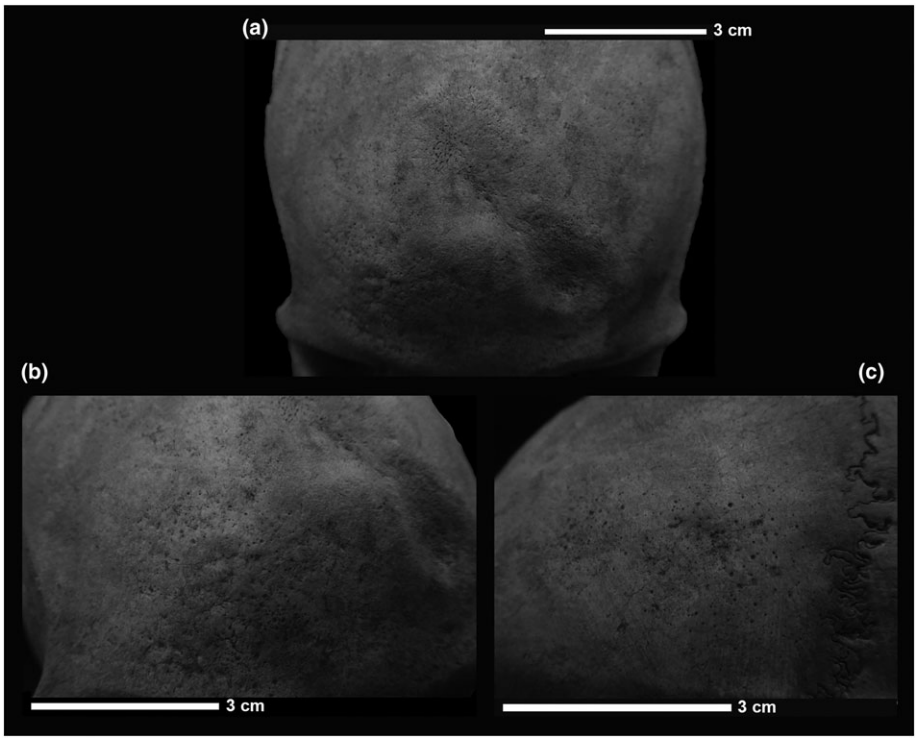

FIGURE 7 Lesions recorded in the frontal bone of cranial vault: (a) middle sector; (b) right sector; (c) left sector

Chronic leg ulcers, due to vascular problems such as venous stasis or varicose veins, can produce bone reactions in tibia and fibula. Such reactions may include woven and lamellar diaphyseal periosteal reaction, spiculated bone formation, thinness of the cortical bone, and total or partial interosseus membrane sclerosis; they rarely produce lytic lesions (Ortner, 2003; Pinheiro, Cunha, Cordeiro & Nuno Vieira, 2004). Some of these reactions have been observed in the long bones of the legs. However, other evidence such as the bilaterality of the lesions, and the fact that a long bone of the upper limb is also involved led us to reject this diagnosis.

Paget's disease is a bone anomaly of uncertain aetiology that commonly occurs in older male adults (>40 years). Although at first, it usually affects only one bone, it can later expand and involve several bones. This pathology is mainly located in the axial skeleton; femora and tibiae are generally the longest affected bones (Ortner, 2003). Specifically, this disease involves three phases: a lytic (or active) stage, a mixed lytic and sclerotic stage, and a sclerotic (or inactive) stage (Waldron, 2009). These processes of destruction and bone formation result in a characteristic mosaic pattern at the histological level, which is considered pathognomonic of Paget's disease (Ortner, 2003). In the long bones, the lytic process begins in the subchondral bone and progresses to metaphysis and diaphysis. Later, thickening of the cortex by endosteal and periosteal bone deposition occurs. This new bone causes the long bones to bow, resulting in pathological fractures due to the fragility of the bone tissue. These features (a fibrous bony structure, focal radiodensity of the epiphyses, etc.) may be observed radiographically (Aufderheide & Rodríguez-Martín, 1998; Ortner, 2003). In the LCT1-P4, the axial skeleton only shows degenerative lesions, and none of Paget's disease features were observed in long bones, which led us to reject Paget's disease.

Tuberculosis is a chronic infectious disease caused by a bacterium of the genus *Mycobacterium*. *Mycobacterium tuberculosis* is the species that causes direct transmission between humans, usually through the respiratory tract. The primary focus of the infection develops in the lungs and can then spread through the blood stream to distant organs, including bone (Ortner, 2003; Waldron, 2009). Tuberculosis affects mostly the axial skeleton, particularly the vertebral bodies. The lesions tend to be destructive rather than formative. Tuberculosis can also cause skull vault lesions, mainly on the inner table (Ortner, 2008). This disease rarely affects the diaphysis of long bones; and when it does, it is most common in children, and it involves the metaphysis and epiphysis. In the rare cases in which the diaphysis is affected, injuries occur in more than one bone and the joint surfaces are involved (Aufderheide & Rodríguez-Martín, 1998; Ortner, 2003). In LTC1-P4, bone formation predominates, the axial skeleton is affected only by degenerative lesions, and the diaphyses show lesions. Due to these characteristics, tuberculosis was also ruled out in this differential diagnosis.

Leprosy is a chronic infection caused by *Mycobacterium leprae*. This pathology affects the peripheral nervous system and the skin. In the advanced stage of the illness, the skeleton is also affected (Ortner, 2003; Waldron, 1994). The bone changes may be specific (due to the direct infection of bone with the bacterium) or secondary (resulting from other effects such as trauma, chronic infection, and deformity, among others; Waldron, 1994). The main lesions occur in the rhinomaxillary region, metacarpals, and hand and foot phalanges. In addition, the infection of the foot can involve the distal tibia and fibula, causing bilateral and symmetrical periostitis (Aufderheide & Rodríguez-Martín, 1998; Ortner, 2003). In the rhinomaxillary region, the changes consist mainly in a resorption of the alveolar process in the centre of the maxilla, destruction of the anterior nasal spine, and resorption of the nasal septum and of the margins of the nasal aperture (Waldron, 1994). These lesions are called "*facies leprosa*"

(Møller-Christensen, Bakke, Melson, & Waaler, 1952). In the hands and feet, usually in the metacarpals and metatarsals, the concentric loss of cortical bone takes place, resulting in diaphyseal remodelling with concentric or knife-edge patterns and cupping deformity of the joints. This remodelling begins in the distal ends of bone and may extend to the proximal region (Aufderheide & Rodríguez-Martín, 1998; Ortner, 2003). The destructive remodelling in the metatarsals can result in a blade-like diaphysis of the bone, and this is considered pathognomonic of leprosy. In our case, the lack of lesions in the rhinomaxillary region and in the hands and feet does not support the diagnosis of leprosy.

Osteomyelitis is a progressive bone infection, involving the cortex, the medullary cavity, and the surrounding soft tissues. As a result, inflammation, bone necrosis, and new bone formation occur (Brady, Leid, Costerton, & Shirtliff, 2006; McNally & Nagarajah, 2010). The aetiology of this infection is mainly bacterial of pyogenic nature, and the most common agent in clinical cases is *Staphylococcus aureus* (Calhoun, Manring, & Shirtliff, 2009; Ikpeme, Ngi, & Ikpeme, 2010). Once the microorganism enters the bone through a feeding artery and expands along the blood vessels, the initial response of the host to infection is generally an acute inflammatory reaction that triggers various physiological changes (Bohndorf, 2004; Brady et al., 2006). These changes lead to the formation of a necrotic area in bone cortex (sequestrum), which is isolated by granulation tissue. The lesion also stimulates osteoblastic periosteal cells, which begin to form new bone (involucrum). This involucrum surrounds the sequestrum, and it can be perforated by cloaca for drainage of sequestrum and/or pus, and thus, the internal pressure of the medullary cavity is released. The newly formed bone tissue gains density, thickness, and maturity over time, to form part of the remodelled diaphysis (Calhoun et al., 2009; Ikpeme et al., 2010; McNally & Nagarajah, 2010). There are different classifications of osteomyelitis. Haematogenous osteomyelitis occurs when the bacteria spread to the bone from the bloodstream (Aufderheide & Rodríguez-Martín, 1998; Brady et al., 2006) and is typical of children. In adults, this type of infection occurs in flat bones and vertebral bodies (Bohndorf, 2004). However, in a child who has had this disease and survived it, reactivation can occur in adulthood after a latency period and it involves several years of this individual's life (McNally & Nagarajah, 2010). Another type of osteomyelitis is secondary to a contiguous focus of infection. This type occurs after a trauma (e.g., fracture) or penetrating wounds (e.g., ulcers), and the diaphyses of long bones are most commonly affected (Bohndorf, 2004). In all cases, sequestrum, involucrum, and cloaca are typical characteristics of osteomyelitis, and they are considered pathognomonic by some authors (Waldron, 2009). In LTC1-P4, sequestrum, involucrum, and cloaca were not registered. However, the cavity in the left patella and two lytic lesions in the cortical tissue of the right tibia were recorded in X-rays. Regarding the injury in the patella, it will be necessary to perform a tomography to determine whether this injury is a cloaca or the result of septic arthritis. As mentioned above, no bone changes were observed at the knee joints. Regarding the cortical lesions in the right tibia, lytic areas surrounded by reactive sclerosis evident in plain radiographic are usually interpreted as osteomyelitis (Flensborg, Suby, & Martínez, 2013; Mellado Santos, 2006; Santos & Suby, 2012). However, as explained below, we ruled out osteomyelitis because of other lesions registered in the skeleton.

In the differential diagnosis, the treponematosis was considered a chronic infection caused by a microorganism called spirochetes of the genus *Treponema*. Treponemal disease is transmitted interpersonally from open lesions to breaks in the skin. If the disease is not treated, it can spread throughout the body via the circulatory system and progress towards more harmful stages (Cook & Powell, 2012; Larsen, 1997). Four treponematoses are recognised: venereal syphilis (*Treponema pallidum pallidum*), endemic syphilis or nonvenereal syphilis (*T. pallidum endemicum*), yaws (*Treponema pallidum pertenue*), and pinta (*T. caretum*; Larsen, 1997; Ortner, 2008). All of them, except for pinta, can produce skeletal lesions, which correspond to the tertiary stage of the disease (Reissech et al., 2011). As the types of injuries are similar, it is difficult to determine the type of syndrome (Aufderheide & Rodríguez-Martín, 1998; Hackett, 1976; Ortner, 2003). However, depending on the stage of development of the pathology, the prevalence of the lesions varies by element (Cook & Powell, 2012, table 26.1). The bones most affected by treponematosis are the skull vault and bones of forearm and lower leg (Ortner, 2008). The lesions in the skull were extensively studied and described by Hackett (1976), *caries sicca* being the pathognomonic lesion of treponemal infection. Rhinomaxillar lesion is also highly characteristic of treponemal infection (Marden & Ortner, 2011; Ortner, 2008). In the long bones, the changes are bone formation, destructive lesions, or a destructive focus surrounded by bone formation. In the tibia, a bone formation in the anterior crest occurs, and this bone takes the shape of a sabre (Hackett, 1976; Ortner, 2003). Likewise, bowing of bone does not occur in acquired syphilis in adults (Ortner, 2008). In the cranial vault and the anterior tibia, bone surfaces with close proximity to skin active lesions or pitted defect from gummatous granulomas are expected.

In skeleton LTC1-P4, bone lesions were recorded in the left forearm and both legs, and they are characterised by bone formation and possible striated nodes with a central cavitation in the right tibia, such as those described by Hackett (1976). Neither tibia is bowed, whereas the external morphology of the tibiae is altered with enlarged appearance. This coincides with the obliteration of the medullary cavity by the thickening of the cortical tissue and the growth of the spongy tissue. The observed lesions in this skeleton are compatible with treponematosis. Particularly, the new medullary bone in the distal tibia, together with the bilaterality of the lesions in the leg bones, is one of the strongest arguments to propose treponematosis. Furthermore, we associated the cured and sclerotic depression observed in the external table of the frontal and the abnormal thickening of the diploe with the types of advanced *caries sicca* lesions recorded in skulls of individuals with treponematosis. Likewise, the two adjacent zones with slight porosity could be interpreted as initial stages of *caries sicca* (Hackett, 1976, pp. 31–40). We emphasise that the nasal region and the palate do not present any lesions, like those usually observed in some individuals who suffered from treponematosis (Cook & Powell, 2012; Lovell, Jurmain & Kilgore 2000).

As stated above, differentiating among the types of treponematosis based on bone changes is difficult. However, some characteristics help distinguish between them. Endemic syphilis and yaws reach their tertiary development—with incidence in the bones—several years after

the initial phase of the infection. They are transmitted mainly by direct contact through skin lesions, although they can also be transmitted by an insect that acts as a vector (Powell & Cook, 2005). Endemic syphilis can also be spread by sharing containers used for eating and drinking (Aufderheide & Rodríguez-Martín, 1998; Powell & Cook, 2005). On the other hand, congenital venereal syphilis is transmitted via the placenta from the infected mother to the fetus or through the birth canal; and often, the normal development of the bone and teeth in the children is affected (e.g., Hutchinson's incisors; Aufderheide & Rodríguez-Martín, 1998; Jacobi, Cook, Corruccini, & Handler, 1992). Acquired venereal syphilis is transmitted via sexual or nonsexual contact of exudates from open lesions (Aufderheide & Rodríguez-Martín, 1998). This syndrome usually occurs at later ages (15–30 years of age), and its tertiary development may occur many years later (Aufderheide & Rodríguez-Martín, 1998). To sum up the differential diagnosis, most of the lesions observed in the skeleton of the female adult can be linked to treponematosis, and they possibly correspond to nonvenereal form because we did not observe any of the common lesions of venereal syphilis.

5 | DISCUSSION AND CONCLUSIONS

In recent decades, paleopathological studies have gathered momentum in Argentina. As a result, there has been a significant increase in the number of studies that describe the pathologies of different etiologies, including infectious ones (Castro, Salceda, Plischuk, & Desántolo, 2009; Della Negra & Novellino, 2005; Flensborg et al., 2013; García Guraieb, Bernal, González, Bosio, & Aguerre, 2009; Kozameh & Brunás, 2013; Mansegosa & Chiavazza, 2015; Suby, Zangrando, & Piana, 2011; among others). Particularly in Northeast Argentina, two cases of pre-Hispanic skeletons with treponematosis were reported. In an archaeological site of the lower Delta of the Paraná River (Túmulo 1 del Brazo Largo), Torres (1911) described a skeleton of a male adult with injuries in many bones and linked them to a hereditary syphilitic infection. These lesions are located in the skull, clavicle, ulna, radius, and both tibiae. Torres did not mention the existence of dental malformations typical of congenital syphilis, so the venereal and hereditary character cannot be confirmed, at least for the moment. However, the descriptions and photographs of the tibias presented by the author show the characteristic sabre-shape associated with treponematosis. Beyond the descriptions made by Torres at the beginning of the 20th century, these skeletons were not re-examined or analysed to support these diagnoses. Also, Cornero and Puche (2007) mention a male adult skeleton in which they macroscopically observed lesions in the right ulna and both tibiae, which they attribute to treponematosis. This skeleton comes from La Lechuza site (Middle Paraná River), associated with the Goya-Malabrigo archaeological entity.

This article is particularly relevant because it presents a possible case of treponematosis, determined by multiple diagnostic procedures (X-ray and CT scans), resulting in a differential diagnosis. These aspects have been relatively unexplored in the bioarchaeology of the area. In the medium term, these works will contribute to the understanding of the state of health of the populations that inhabited the area in the Late Holocene. Furthermore, our studies deepen the paleopathological analyses framed within archaeological studies to assess the impact of factors such as the decrease in residential mobility and demographic growth on the biology of these populations.

The case study presented in this article will allow us to evaluate the hypotheses that link this treponemal pathology with social aggregation and climatic conditions. Environmentally, the Paraná Delta presents a humid climate with abundant rainfall. It is a complex water network formed by rivers, streams, lagoons, and swamps. It is affected by periodic floods that cover a large area of the land for extended periods of time. These environmental characteristics favoured the concentration of people in the highest areas of the landscape (Baigún, Puig, & Minotti, 2008; Bó & Malvárez, 1999; Castiñeira Latorre et al., 2017). Particularly, the living spaces occupied by the archaeological entity Goya-Malabrigo for prolonged periods of time were the anthropic mounds unaffected by the floods (Politis, 2014; Politis & Bonomo, 2012). The warm and humid climates that characterise the subtropical regions also favoured the development of treponemal lesions (Hutchinson, Larsen, Williamson, Green-Clow, & Powell, 2005, p. 108). In addition, social factors such as sedentarism, population concentration (Hutchinson et al., 2005; Powell, Jacobi, Danforth, & Eisenberg, 2005; Smith, 2006; Smith & Betsinger, 2015; Wilson, 2005), and poor community hygiene (Csonka & Pace, 1985; Hackett, 1976) have been associated with the presence of the treponemal disease. In future study, we will evaluate and discuss this case study in the archaeological and environmental context of the Delta del Paraná.

Finally, the individual with treponematosis reported here extends the record of the presence of this pathology in pre-Hispanic times in the New World, particularly for these latitudes, where evidence is scarce (Marden & Ortner, 2011; Powell & Cook, 2005; Santos, Gardner, & Allsworth-Jones, 2013).

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