

Two (Missing) Left Feet: Caring for Foot Amputees in Late Pre-Hispanic Túcume, Lambayeque Peru

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ABSTRACT Understanding pre-Hispanic Andean medical practices through skeletal evidence of surgery has been the focus of a number of bioarchaeological investigations in recent years. Amputation is an especially interesting topic of research due to the variety of social contexts in which it might have occurred. Interpretations for amputation found on the north coast of Peru have included therapeutic intervention, punitive measures, and ritualistic dismemberment. Here, we present two new cases of successful left foot amputation in young adult females excavated from Huaca Las Balsas (Late Intermediate Period, A.D. 1100–1470) and Huaca Las Abejas (Late Horizon, A.D. 1470–1535) at the ancient religious and administrative center of Túcume. Chronologically, they are the latest cases of pre-Hispanic amputation published to date. Contextual evidence supports a therapeutic motivation for the procedure, as individualized burial treatment and placement within a cemetery group of social elites is not consistent with punitive or ritualistic action. Modification of the malleoli, extensive bone proliferation covering the talar articulations, and asymmetrical cortical bone thickness of the tibiae and fibulae (revealed radiographically) suggest the return of some functional mobility using the affected limb after healing. This long-term recovery is evidence of access to quality medical care and accommodation of functional impairment within the amputees' communities. The presented research uses the bioarchaeology of care approach to explore the lived experiences of these amputees and their social identities, making an important contribution to the anthropology of disability across cultures and time periods.

Keywords: amputation; ancient medical practice; bioarchaeology of care; disability; skeletal trauma; surgery

Comprender las prácticas médicas andinas prehispánicas a través de evidencia esquelética de cirugía ha sido el foco de una serie de investigaciones bioarqueológicas en los últimos años. La amputación es un tema de investigación especialmente interesante debido a la variedad de contextos sociales en los que podría haber ocurrido. Las interpretaciones para la amputación que se encuentran en la costa norte del Perú han incluido la intervención terapéutica, las medidas punitivas y el desmembramiento ritual. Aquí, presentamos dos nuevos casos de amputación exitosa del pie izquierdo en hembras adultas jóvenes excavadas desde Huaca Las Balsas (Período Intermedio Tardío, A.D. 1100–1470) y Huaca Las Abejas (Horizonte Tardío, D.C. 1470–1535) en el antiguo centro religioso y administrativo de Túcume. Cronológicamente, son los últimos casos de amputación prehispánica publicados hasta la fecha. La evidencia contextual apoya una motivación terapéutica para el procedimiento, ya que el tratamiento y la colocación individualizados del entierro dentro de un grupo cementerio de élites sociales

no es consistente con la acción punitiva o ritualista. La modificación de los maléolos, la extensa proliferación ósea que cubre las articulaciones talaras y el grosor óseo cortical asimétrico de las tibia y los peronés (revelados radiográficamente) sugieren el regreso de cierta movilidad funcional utilizando la extremidad afectada después de la curación. Esta recuperación a largo plazo es evidencia del acceso a atención médica de calidad y alojamiento de deterioro funcional dentro de las comunidades de amputados. La investigación presentada utiliza la “bioarqueología de la caridad” para explorar las experiencias vividas de estos amputados y sus identidades sociales, haciendo una contribución importante a la antropología de la discapacidad a través de las culturas y períodos de tiempo.

Two huacas, both alike in dignity,

(In fair Túcume, where we lay our scene),

From ancient ground break new amputees,

Where literal dirt made our hands unclean.

—*Modified for contextual purposes from Shakespeare (1597:1)*

Limb amputation is one of the oldest known surgical procedures (Markatos et al. 2019; Sachs et al. 1999), documented by both historical and archaeological record. It is defined as the intentional removal of a limb, either partially or completely (Marcovitch 2009:28). The earliest possible evidence of this practice dates to the Neandertals buried in Shanidar Cave, Iraq, over 40,000 years ago (Stewart 1977), and archaeological evidence of both successful and unsuccessful ancient amputations has been found globally. Examples exist in England (Mays 1996), Portugal (Fernandes et al. 2017), France (Buquet-Marcon et al. 2007), Bulgaria (Zäuner et al. 2013), South Africa (Van der Merwe et al. 2010), and Egypt (Dupras et al. 2010; Nerlich et al. 2000). Moreover, amputation remains as medically relevant today as it was in the past. Although surgical practices have evolved significantly, with advances in anesthetic, imaging, and operative technologies, the removal of an appendage is a life-altering procedure that continues to be used in the treatment of trauma (Ahmad et al. 2019; Barla et al. 2017; Moini et al. 2009), circulatory and neuropathic issues (Nanwani et al. 2019), localized infections (Boffeli 2015), and other conditions (Zhao et al. 2020).

This article expands current understandings of the history and social implications of amputation by presenting two new cases from Túcume, Peru, dated to the Late Intermediate Period (A.D. 1100–1470) and Late Horizon (A.D. 1470–1532). These cases evidence a regional continuity of surgical practices that endured for hundreds of years between the Moche culture (A.D. 100–700) and the Inca empire (A.D. 1470–1532). Additionally, utilization of the bioarchaeology of care approach (Tilley 2015; Tilley and Cameron 2014) allows these cases to be framed as reflections of

community care practices and lived experiences of amputees in north coastal Peru. The bioarchaeology of care is essential to understanding the nuances of chronic functional impairment in the past—an important contribution to modern disability studies.

Although functional impairment, healthcare, and disability are separate concepts that should not be conflated, they are often intertwined. This analysis of amputation at Túcume explores the possibility that the survival of Andean amputees in the distant past was aided by community members and urban infrastructure. However, it simultaneously acknowledges the position of amputees as agentive community members that might or might not have actually been considered disabled. In contrast to previously discovered cases of pre-Hispanic amputation in the region, skeletal and mortuary evidence from Túcume suggests that amputation occurred as a form of medical intervention, and accommodation of resulting physical limitations fell within contemporary cultural norms.

Bioarchaeology of Care

The bioarchaeology of care (Tilley 2015; Tilley and Cameron 2014) is an emerging interpretive framework in bioarchaeology that emphasizes the role of community in the lives of impaired or disabled individuals. This can involve the provision of medical care for acute or chronic ailments, general task assistance, and emotional support offered to a person with a limiting condition either directly (often by kin) or indirectly within an accommodating sociopolitical structure. The identities of impaired or disabled individuals are highly dependent on cultural context and are situationally malleable, and not all functionally

impaired people identify as disabled or require significant structural accommodation to complete essential tasks (Byrnes and Muller 2017; Kasnitz and Shuttleworth 2001; Reid-Cunningham 2009). However, survival and quality of life of a person with impaired functional abilities often rely on interpersonal and structural accommodation. This includes healthcare access, which is often dependent on socioeconomic status (Becker and Newsom 2003; Kristiansson et al. 2009; Walters and Suhrcke 2005), and cultural perceptions of impairment (Rösing 1999).

The bioarchaeology of care has become an invaluable framework to guide paleopathological analysis because of its ability to integrate social theory related to identity and compassion (Tilley 2015; Tilley and Schrenk 2017). Due to the intangibility of emotions such as compassion (Dettwyler 1991), some bioarchaeologists shy away from the more ephemeral aspects of the approach. However, regardless of

emotional consideration, the bioarchaeology of care has proven its utility in a wide variety of social contexts that range from hunter-gatherer groups (Tilley and Oxenham 2011; Tilley 2015) to recent historical institutions (Tremblay Critcher 2017; Wesp 2017). Previous examples of the bioarchaeology of care in Peru include publications that address trepanation (Jolly and Kurin 2017), crippling Thoracic Outlet Syndrome (Palma Málaga and Makowski 2019), and chronic post-injury osteomyelitis (Sutherland 2019) as conditions that affected individuals and their caretakers in late pre-Inca cultures of central and south-central parts of the country.

Amputation in Pre-Hispanic Peru

The history of the bioarchaeology of care in Peru is currently limited, considering the relatively

Table 1. Presently Published Examples of Pedal Amputation from Pre-Hispanic North Coast Peru.

Site	Time Period and Culture	Individual	Age and Sex	Side	Suggested Motivation
Túcume ¹	Late Horizon, Chimú-Inca	H. Las Abejas, unit XA, Ent. 1	Young adult female	Left	Medical/therapeutic amputation
Túcume ¹	Late Intermediate Period, Lambayeque	H. Las Balsas, unit IB, Ent. 1	Young adult female	Left	Medical/therapeutic amputation
Castillo de Huaramey ²	Middle Horizon, Wari	Imperial tomb, Individual XY	Young adult male	Left	Ritual amputation
Castillo de Huaramey ²	Middle Horizon, Wari	Imperial tomb, Individual XX	Middle adult female	Left	Ritual amputation
El Brujo ³	Early Intermediate Period, Moche	West Sector, Tomb 4	Middle adult male	Both	Intentional amputation
El Brujo ³	Early Intermediate Period, Moche	Huaca Cao, BRU M98-4	Adult male	Left	Intentional amputation
Mocollope ³	Early Intermediate Period, Moche	MOC98-1	Young adult female	Right	Intentional amputation
Mocollope ⁴	Early Intermediate Period, Moche	—	Unknown adult	Both	Punitive amputation
Huacas de Moche ⁵	Early Intermediate Period, Moche	Plataforma Uhle, Tomb 48	Young adult male	Left	Not considered

¹Present study

²Więckowski (2016)

³Verano et al. (2000)

⁴Vélez López (1913)

⁵Chauchat et al. (2009)

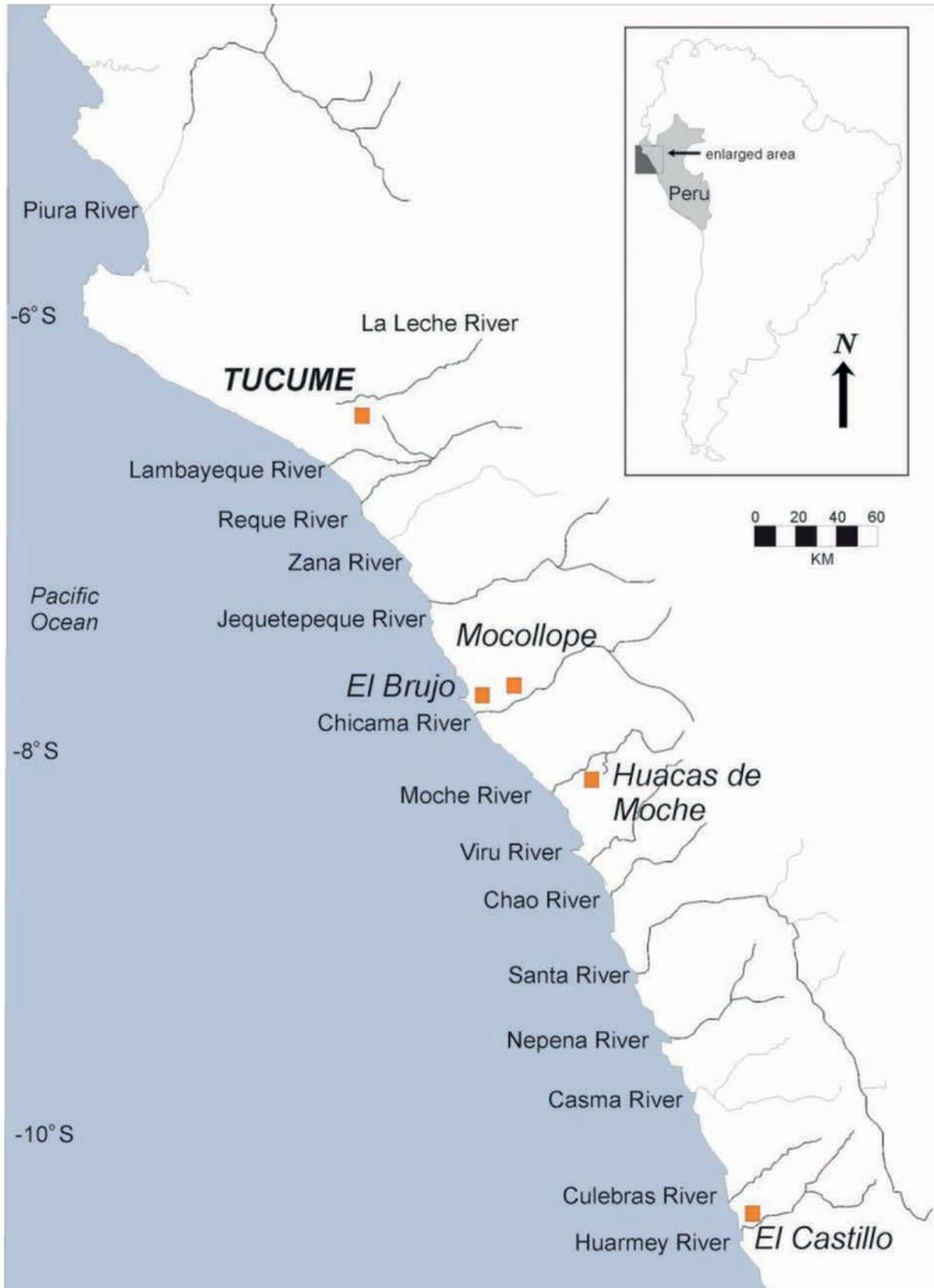


Figure 1. Map of north coast of Peru showing locations of sites mentioned in the text. Map created by Toyne.

recent definition of this theoretical paradigm, and there is much room for expansion. This article seeks to continue the regional application of the bioarchaeology of care with the analysis of amputees from Peru's north coast. The cases presented provide an important extension of previous discussions of pre-Hispanic Peruvian amputation practices by providing fresh evidence for surgical practices, motivations, and effects on long-term identity and social integration.

Previously identified cases of pre-Hispanic pedal amputation include those published by Vélez López (1913), Alva and Donnan (1993), Verano (1997), Verano et al. (2000), Chauchat et al. (2009), and Więckowski (2016) (Table 1). Some of these examples of foot removal, all of which were found on the north coast of Peru, are presumed to have been well-healed antemortem amputations due to bony remodeling of the affected area. However, other examples of missing feet in the bioarchaeological record are less easily interpretable. Although Verano (1997) and Alva and Donnan (1993) note that a footless “guard” was placed at the entrance to Tomb I and at the entrance to Tomb II at Sipán (an elite Moche burial site), the poor preservation of these skeletons inhibited observation of their distal lower leg bones. It is therefore unclear whether the missing feet of these tomb guardians reflect antemortem amputation or postmortem removal.

Of the individuals who do provide evidence for antemortem foot amputation, the earliest were found at the site of Mocollope, the El Brujo complex, and the Huacas de Moche complex (Fig. 1). All of these early cases are associated with the Moche culture (A.D. 100–700) (Chauchat et al. 2009; Vélez López 1913; Verano et al. 2000). The contextual evidence does not suggest that these individuals were intentionally amputated to serve as tomb guardians. While the motivation is unknown, it is evident that each individual survived long enough to support substantial remodeling of the ankle joint after removal of the foot. The amputees found at the Castillo de Huarmey (Więckowski 2016) (Fig. 1), associated with the Wari culture (A.D. 600–1100), also seem to have been long-term survivors of amputation. However, they ultimately served as tomb guardians. They were buried in a distinct location in the floor of the antechamber to the Wari imperial mausoleum of elite women.

The placement of footless individuals as apparent guardians at the entrance to elite tombs suggests a symbolic or spiritual importance of feet and foot amputation among the Moche as well as the Wari. This possibility is supported by the frequent depiction of isolated feet and foot amputees in Moche ceramics (Paico Vélchez and Paico Zumaeta 2020; Vélez López 1913

and the appearance of isolated feet in Wari ceramics (Trigo Rodríguez and Hidalgo Rocabado 2012; Więckowski 2016). However, although a general cultural fascination with feet and foot removal is suggested by this type of artistic expression, ceramics might also lend evidence to punitive or therapeutic theories regarding the motivations underlying amputation. For example, amputees depicted by the Moche sometimes have a mutilated nose and lips, which could be interpreted either as punitive maiming or as a symptom of a pathological condition such as nasal leishmaniasis (Verano et al. 2000). Amputation of the foot (or feet) could have been an additional punitive measure or intended as a treatment for a pathological condition that affected hands and feet. As it is depicted in ceramics, amputation motivated by advanced leishmaniasis, or a similar condition, is considered unlikely due to the unaffected appearance of non-amputated extremities. Nonetheless, this does not rule out other medical reasons for amputation in the ceramic or bioarchaeological record.

Non-punitive amputation that is not ideologically motivated is suggested by the burial of some individuals in traditional, non-guardian burial contexts. This includes the burial contexts of amputees found at El Brujo and Mocollope (Verano et al. 2000), Huacas de Moche (Chauchat et al. 2009), and Túcume (this publication).

Archaeological Context

Túcume is an extensive archaeological complex located within the La Leche River Valley, approximately 30 kilometers north of the modern Lambayeque regional capital of Chiclayo. Initially associated with the Lambayeque culture (A.D. 900–1350), the history of Túcume covers more than 400 years of occupation and three major shifts in political control (Heyerdahl et al. 1995; Shimada 1981, 2009). Monumental construction at Túcume commenced during the Late Intermediate Period at the site (A.D. 1050), and it continued for roughly three centuries until the region was incorporated into the north coastal Chimú empire around A.D. 1350 (Heyerdahl et al. 1995). Around A.D. 1470, the Inca empire that was rapidly expanding from Peru's southern highlands conquered the Lambayeque Valley region. The Inca appear to have used Túcume as their primary regional administrative center until the arrival of the Spanish in A.D. 1532, when the site was burned and ultimately abandoned (Covey 2008; Narváez Vargas 1995b; Sandweiss 1995).

The administrative and religious core of the complex consists of 26 truncated adobe pyramids

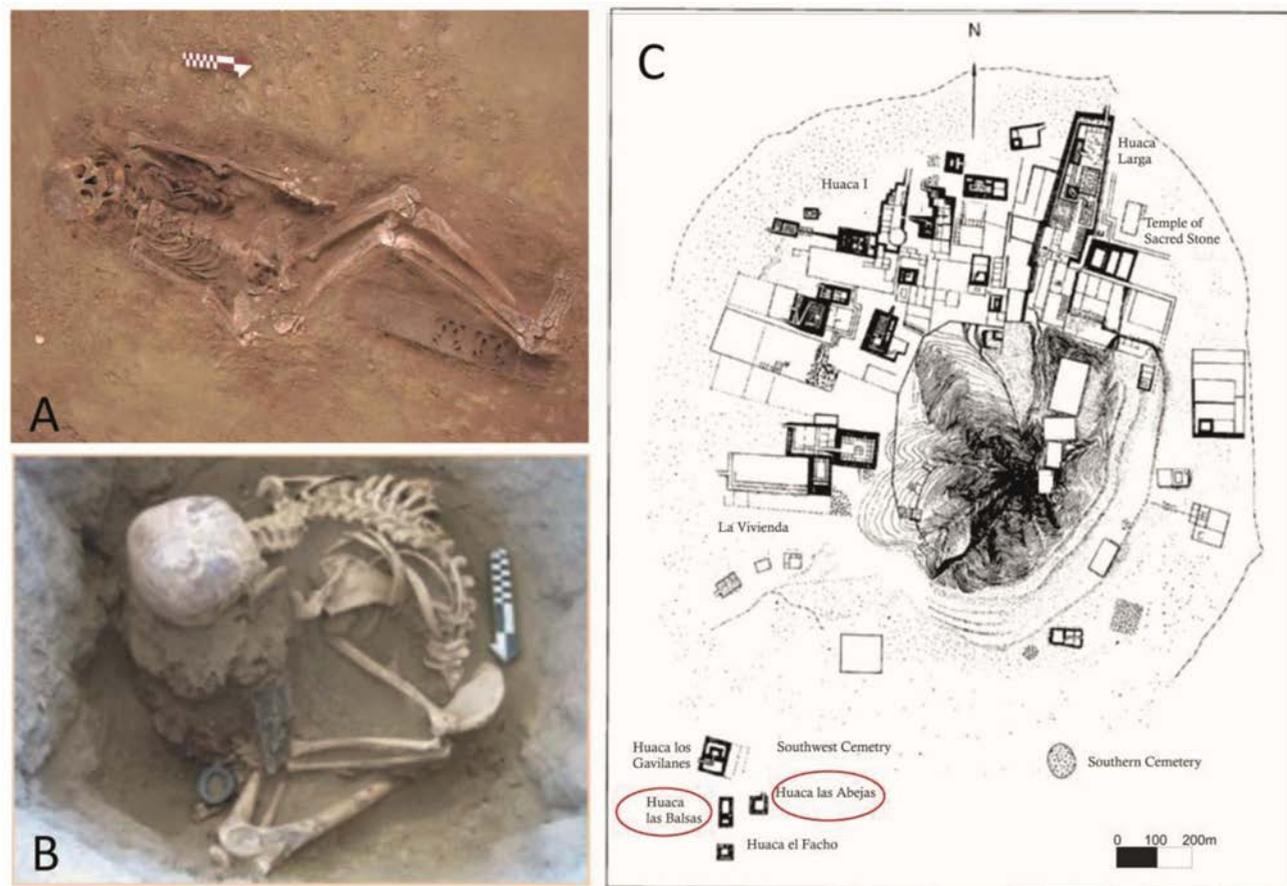


Figure 2. (a) Burial of Case 1 (Las Balsas, unit IB, Entierro 1) shown in situ with extended body position. (b) Burial of Case 2 (Las Abejas, unit XA, Entierro 1) shown in situ, seated and flexed with a few grave goods. (c) Map of the Túcume archaeological complex, with Huaca Las Abejas and Huaca Las Balsas circled. Figure created by Toyne.

(Fig. 2)—called *huacas* due to their status as sacred pre-Hispanic monuments. These *huacas* were built during the Lambayeque occupation around a steep rocky outcropping named Cerro La Raya (Delgado Elías and Narváez Vargas 2016; Narváez Vargas 1995b; Narváez Vargas and Delgado Elías 2011; Sandweiss 1995). They vary greatly in size and structural complexity due to their differential uses for administrative, ceremonial, and elite residential purposes. Huaca Las Balsas and Huaca Las Abejas are among those found in the southwestern sector of the archaeological complex. They appear to have functioned as residences and mortuary monuments for associated cemeteries containing social elites (Delgado Elías and Narváez Vargas 2016; Narváez Vargas 1995a; Narváez Vargas and Delgado Elías 2011).

Huaca Las Balsas is a moderately sized platform mound, measuring approximately 35 × 25 m, with a height of approximately 4.5 m (Narváez Vargas and Delgado Elías 2011). Despite its smaller size, Huaca Las Balsas has been the subject of much archaeological inquiry due to the presence of intricate carved

murals on its walls. The murals depict maritime scenes, including divers collecting *Spondylus* and anthropomorphic bird figures sailing on wooden rafts (*balsas*). Along with these murals, which inspired the *huaca*'s modern name, the main features of the construction include superficial residential structures, cooking areas, two descending ritual platform areas, and a small platform containing eight burials. These Lambayeque burials (approximately A.D. 1240–1300) include adult males and females as well as juvenile individuals, and grave associations indicate middle elite social status (Delgado Elías and Narváez Vargas 2016; Narváez Vargas and Delgado Elías 2011).

Huaca Las Abejas measures approximately 57 meters in length and width and 8 meters in height. The initial architectural survey revealed three construction phases of ritual platforms and a ramp, likely from the Late Intermediate Period (A.D. 900–1470) (Escudero Villalta 2018). Unlike Huaca Las Balsas, excavations have yet to identify residential structures or burials on top of Huaca Las Abejas. However, a small cemetery to the north of the *huaca* contained

28 well-preserved human burials that are of a similar demographic profile to the burials excavated from Huaca Las Balsas. The interred individuals were of middle elite status, although they have been dated to the Late Horizon (approximately A.D. 1470–1532) based on associated ceramic materials and the seated, flexed burial positioning that are characteristic of Chimú-Inca occupation (Escudero Villalta 2018).

Materials and Methods

Toyne conducted osteological analysis of the skeletons in the field in 2009 and 2014, including metric and morphological observations, following the standards established by Buikstra and Ubelaker (1994) and Ubelaker (1999). Biological assessment of age at death and sex were estimated based on morphological characteristics of the os coxae and crania. Stature was estimated using tibial condylomalleolar length (CLT) using the regression equation proposed by Pomeroy and Stock (2012) ($\text{stature} = 57.748 + 2.800\text{CLT}$), which was recommended for regional accuracy by Anzellini and Toyne (2020). Macroscopic observations of pathological bone modification were recorded based on visual examinations, including evidence for traumatic damage, bone remodeling, and inflammatory response (Ortner 2012). Other pathological changes observed include cranial modification, dental pathology, and osteoarthritic joint changes. Finally, key skeletal elements (right and left humeri, femora, and tibiae) were transported to the Econor diagnostic imaging clinic in Lambayeque, Peru, where standard film, single-plane radiographs were taken.

Analysis of these individuals was conducted according to standard bioarchaeology of care guidelines (Tilley 2015; Tilley and Cameron 2014). The following sections of this report document the process of bioarchaeology of care analysis through four prescribed steps. These steps ensure appropriate consideration of functional impairment and the healthcare that might have been necessary for an impaired person's survival. They include: (1) description, diagnosis, and documentation of the pathological condition from skeletal and other bioarchaeological evidence; (2) determination of whether or not an individual would have received medical and/or other care from their community; (3) construction of a model of care that might have been necessary for an impaired individual's survival; and (4) interpretation of the model of care in a broader social context.



Figure 3. The almost-complete skeleton of Case 1 (Las Balsas, unit IB, Entierro 1). Photo by Toyne.

Description, Diagnosis, and Documentation

Description of Case 1: Las Balsas, Unit IB, Entierro 1

This individual (female, between 30 and 40 years) was buried atop Huaca Las Balsas in a simple pit. The skeleton was in an extended position with slight flexing of the legs, positioned with the head to the south (Fig. 2). This burial was part of the group of eight burials, including a camelid. Radiocarbon dates from nearby Entierro 5 produced a date between cal A.D. 1240 and 1300 (720 \pm 40 B.P.),

which corresponds to the Lambayeque occupation of the Late Intermediate Period.

Grave position and associations of the individual from Huaca Las Balsas are similar to materials recovered from other Lambayeque-style burials at the site (Narváez Vargas 1995a). For individuals identified as female based on skeletal indicators, burial treatment generally consisted of interment in the extended or slightly flexed position and accompaniment by a variety of functional vessels and weaving-related items. In this particular grave, there were four gourd bowls, one small ceramic cooking pot, two small copper beads near the cranium, and 68 spondylus shell beads near the right and left wrists. The weaving-related items found in the grave include three decorated wooden weaving loom pieces, a gourd needle container, three copper needles, various balls of threads, and chalk. The body was wrapped in a poorly preserved, simple, brown cotton textile.

This individual was represented by an almost complete, well-preserved skeleton with minor taphonomic breakage and surface erosion (Fig. 3). Missing skeletal elements included the left calcaneus, talus, tarsal bones, metatarsal bones, and pedal phalanges (although these elements are thought to be missing due to pathological rather than taphonomic reasons). Using the non-pathological right tibia, stature was estimated to be 144.6 cm. This is slightly shorter than the average height of 147.9 cm ($\sigma = 3.08$ cm) that was

calculated for the seven other adult females interred within similar burial contexts at Túcume.

The cranium is intact and exhibits a moderate degree of cranial modification, showing flattening across the frontal and occipital bones that resulted in bilateral bulging of the parietal bones. Remodeled macroporosity on the posterior bones of the cranial vault is consistent with healed porotic hyperostosis. Observations of the dentition revealed a moderate degree of dental attrition that resulted in flat occlusal surfaces of all teeth, four well-healed alveolar sockets indicative of antemortem tooth loss, some hypoplastic defects of the anterior dentition, and four alveolar abscesses that caused resorption of the maxilla. There was also a large carious lesion of the mandibular second molar and minimal dental calculus on the labial surfaces of most teeth. In the postcranial skeleton, two small Schmorl's nodes were observed on the superior bodies of the ninth and twelfth thoracic vertebrae. Minor osteophytic lipping affected the anterior body margins of the sixth through twelfth thoracic vertebrae.

The key pathological feature on the skeleton was the osteological (morphological and radiographic) modification of the distal portions of the left tibia and fibula (Fig. 4). Although fragility of the affected bone seems to have contributed to some postmortem fragmentation of relevant pathological features, visual observations of the medial malleolus of the tibia



Figure 4. (a) Detailed anterior oblique view of the left distal tibia and fibula of Case 1 (Las Balsas, unit IB, Entierro 1). (b) Fragments of the distal articular surface of the tibia showing bone proliferation. Photos/figure by Toyne.

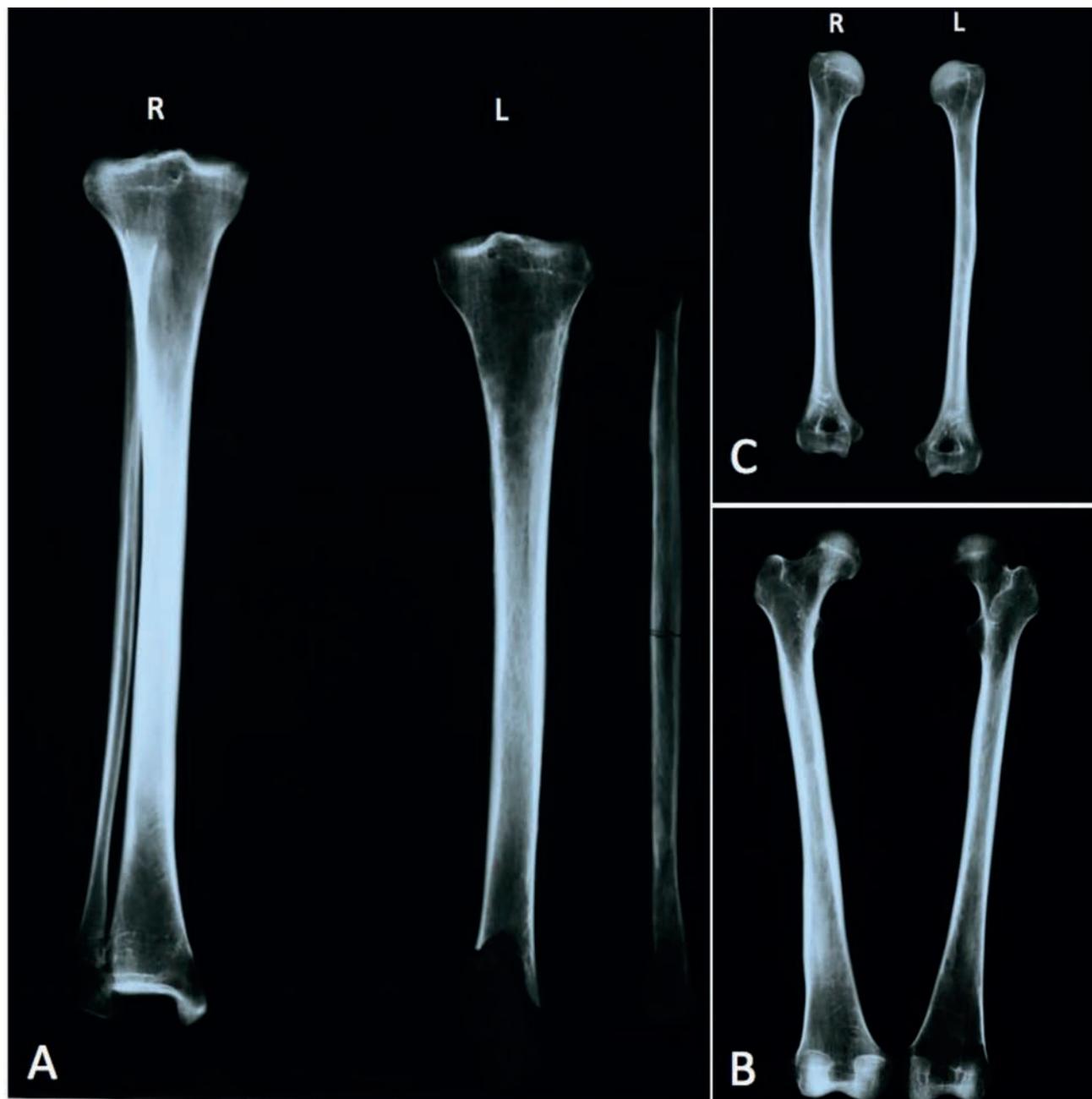


Figure 5. (a) Anterior-view plain film radiograph of the tibiae and fibulae of Case 1 (Las Balsas, unit IB, Entierro 1). (b) Anterior-view plain film radiographs of the femora of Case 1. (c) Anterior-view plain film radiographs of the humeri of Case 1. Figure created by Toyne.

showed that it was not consistent with normal morphology. The recovered fragments of the articular region demonstrate active bone proliferation. There was evidence of healed periosteal reaction along the posterior aspect of the midshaft of the tibia and an area of raised sclerotic bone at the attachment site of the *flexor digitorum longus*. On the fibula, irregular thickening of the distal metaphysis was present. There was also mild medial displacement of the lateral malleolus, possibly the result of a healed fracture. The distal tibio-fibular and talar articular surfaces

were completely remodeled so that no facet remained, and the fibular summit was rounded rather than pyramidal in shape. The attachments for the *flexor hallucis longus* and *soleus* muscles along the left fibular midshaft also showed pronounced rugosity compared to the right side.

Radiographs of both tibiae and fibulae (Fig. 5a) illustrate the difference in cortical thickness and bone density between the right and left sides of the body. The cortical bone of the right tibial and fibular diaphyses are denser and thicker than the left tibial and



Figure 6. The almost-complete skeleton of Case 2 (Las Abejas, unit XA, Entierro 1) from an anterior oblique view, showing termite damage to right femur. Photo by Toyne.

fibular diaphyses. This suggests use-related atrophy and reduced biomechanical forces applied to the left lower leg. Additional radiographs of the femora (Fig. 5b) and humeri (Fig. 5c) also demonstrate asymmetrical bone thickness and density that is consistent with reduced limb use on the left side of the body. The appearance of reduced cortical density in the left humerus is what might be expected if this individual were using a crutch or cane, as one-sided crutch and cane use typically occurs contralaterally to the affected lower limb (Edelstein 2019).

Description of Case 2: Las Abejas, Unit XA, Entierro 1

The second individual (female, approximately 30 to 34 years) was buried in a circular pit in front of the Huaca Las Abejas platform. Stratigraphic registration and grave associations confirm that this burial, as well as the other 27 burials recovered together, date to the later fifteenth-century Chimú-Inca occupation. Burial position also supports this cultural affiliation, as the interred was situated in a seated and flexed body position, with the face collapsed downward over crossed arms and legs (Fig. 2). Typical Chimú-Inca burial practices for middle elite people at Túcume consisted of wrapping bodies in layers of textiles and then interring them in a seated, flexed position. Grave accoutrements for middle elite women typically included functional vessels and weaving tools as well as decorative accessories such as beaded jewelry.

As with other, better-preserved burials from Huacas Las Abejas, the individual described in Case 2 was likely wrapped in several layers of woven cloth textiles to create an egg-like bundle. However, only a few remnants of the burial fabrics remained at the time of excavation. The grave goods associated with this individual include a small ceramic bowl, two intentionally damaged copper sewing needles, a weaving loom end bar, 25 wooden spindles and threads of various colors within a gourd bowl, and a small ball of dark brown wool. Copper and shell beads were found near the wrists. The grave context also included a small, simply decorated jar that contained the seeds of the bichayo (*Capparis crotonoides*) shrub, a plant indigenous to the north coastal region of Peru and commonly used for firewood and animal fodder. The flower and leaves of this plant also have medicinal properties for treating skin rashes and other conditions. When boiled, it can be drunk in a tea to treat bronchitis or inhaled under sauna-like conditions as a remedy for arthritis and bone aches (Bussmann and Sharon 2015).

The adult female skeleton was almost complete and generally well preserved (Fig. 6), although the left calcaneus, talus, tarsal bones, metatarsal bones, and pedal phalanges were absent. Termites caused extensive taphonomic damage by burrowing into the midshaft of the right femur and the distal portion of the left femur, possibly due to the presence of wooden materials within the grave (Huchet et al. 2011). There was also postmortem fragmentation of the left os



Figure 7. Detailed anterior oblique view of the distal tibia and fibula of Case 2 (Las Abejas, unit XA, Entierro 1). Photo by Toyne.

coxa, ribs, and scapula. Bone brittleness might have contributed to this postmortem fracturing, but osteoporosis was not observed. Using the right tibia, her stature was estimated to be approximately 144.6 cm, similar to the estimated stature of the Lambayeque individual from Huaca Las Balsas.

Observations of the dentition found moderate-to-pronounced dental wear that resulted in flattened cusps, as well as a thin layer of dental calculus covering almost all lingual and buccal tooth surfaces. The right maxillary first molar was lost antemortem, as indicated by a well-healed alveolus. Interproximal caries developed between the upper left premolars, and it appears that the third molars of the maxilla and mandible were congenitally absent. Observations of osteopathology revealed no porotic hyperostosis or cribra orbitalia on the bones of the cranium, but the cranial vault did demonstrate a moderate degree of fronto-occipital modification. There were also osteoarthritic changes to some joint surfaces, including those of the shoulders, hips, and right knee. These osteoarthritic changes included minor osteophytic lipping and cortical thinning.

The individual demonstrated significant modification to the distal articular surface of the left tibia and the distal epiphysis of the left fibula. The side-by-side comparison of the right and left lower leg bones is

illustrated in Figure 7. In addition to healed periosteal reaction along the medial aspect of the tibia's distal shaft, extensive bony proliferation densely filled the tibio-talar articulation, and the collicular features of the medial malleolus were remodeled. Only a small area of the original joint surface could be observed to indicate that there had been a normal facet prior to bony remodeling. Although the distal fibula presented with a fairly normal tibio-fibular articulation, there was alteration of the talar articulation. Bone proliferation filled the malleolar fossa and the apex was flattened. There also appeared to be a sharply defined oval void between the two bones at their distalmost point of adjacency, perhaps encapsulating a pocket of soft tissue or a cyst-like feature that provided a barrier to bony proliferation in that specific area.

Radiographs of both tibiae (Fig. 8a) illustrate structural changes to cortical thickness and density in the bones of the left limbs. The midshaft of the left tibia demonstrated thin cortical bone and irregular distal cortical density, and radiographic translucence of the distal periarticular area is indicative of atrophy due to reduced weight-bearing. The left fibula demonstrated similar characteristics. Radiography also revealed possible tendinopathy of the greater trochanter (Fig. 8b) and some minor decreases in cortical bone thickness of the right humerus relative to



Figure 8. (a) Anterior-view plain film radiograph of the tibiae and fibulae of Case 2 (Las Abejas, unit XA, Entierro 1), picturing a right tibial midshaft cut for sampling and a left fibula with postmortem fragmentation. (b) Anterior-view plain film radiographs of the humeri of Case 2. Figure created by Toyne.

what is observable in the left humerus (Fig. 8c). This observation is complemented by what appears to be localized demineralization of the subchondral region of the right humeral head. The osteochondritic radiodensity of the left humeral head may be an artifact of imaging or perhaps some evidence of avascular necrosis suggesting damage to the shoulder joint.

Differential Diagnosis

The individuals found at Huaca Las Balsas (Case 1) and Huaca Las Abejas (Case 2) likely had their left feet removed via disarticulation of the ankle joint several or many years before their deaths. The nature of the bone response at the distal ends of the left tibiae and fibulae is indicative of survival after surgical

amputation, as opposed to congenital absence or incomplete archaeological recovery of foot bones. Unaffected diaphyseal morphology indicates maturation was not disrupted by unbalanced limb functionality, and thus the talus and other foot bones were likely removed after the individuals reached adulthood. Diaphyseal and distal metaphyseal morphology of the tibiae are normal, and abnormal bony proliferation within the talar articular cavity seems to have occurred over a previously functional joint surface in both cases. Although the distal left fibula of the individual from Huaca Las Balsas shows significant metaphyseal remodeling due to an apparent fracture, the distal left fibula of the individual from Huaca Las Abejas is of normal morphology, except for the development of a more bulbous epiphysis.



Figure 9. Oblique medial posterior view of the right femur of Case 1 (Las Balsas, unit IB, Entierro 1) illustrating musculoskeletal bone modification. Photo by Toyne.

This amputation procedure seems to have been intentional and methodical. Accidental or traumatic amputation is unlikely as there is no evidence of severe trauma in either Case 1 or Case 2 to the malleoli of the tibia and fibula, which constitute part of the ankle joint adjacent to the normal position of the talus. Although no cut marks are present on the distal lower leg bones to evidence surgical removal of the foot in either case, it is possible for a well-trained healer to disarticulate the ankle joint by cutting only the soft tissue between the articular surfaces (Kirkup 2007; Markatos et al. 2019). This would not leave cut marks on the bone surfaces. Additionally, if cut marks on the bone were made, it is very likely that bone remodeling would have obscured them over time.

In modern and historic contexts, intentional amputation has been performed as punishment or as a ritual practice (Adejumo and Olabisi Adejumo 2005; Bosmia et al. 2014; Kirkup 2007; Mavroforou et al. 2014). Some have suggested these potential motivations for pre-Hispanic north coast Peruvian amputations (Kirkup 2007; Verano et al. 2000; Więckowski 2016). However, the contexts in which the amputees from Túcume were buried does not indicate that their amputations were performed for a punitive or ideological purpose, as they were not interred in a deviant fashion (Murphy 2008; Shay 1985). Their burial location, body positioning, and grave accoutrements are typical of middle elite women's burials during their respective time periods.

Evidence seems to suggest that the amputations were performed for therapeutic purposes. This conclusion is supported by the fact that, to date, no individuals with severe pathological conditions of the foot have been discovered at Túcume. Absence of

evidence for foot trauma, disease, or malformation in unamputated feet suggests that such conditions might have typically been treated with amputation.

Although trauma, disease, or malformation can be causes for amputation, none of these conditions is strongly evidenced in the amputees from Túcume. The possible healed fracture identified on the distal fibula of the amputee from Huaca Las Balsas (Case 1) could indicate trauma that preceded, succeeded, or was associated with the amputation of the foot. Alternatively, a localized infection or a chronic disease that leaves few or no skeletal indicators could be to blame. For example, diabetes might have led to ulcer development that necessitated pedal amputation. Although there is no skeletal evidence for this condition (Biehler-Gomez et al. 2019; Dupras et al. 2010) in either Case 1 or Case 2, diabetes mellitus is the leading cause of non-traumatic lower limb and foot amputations in the modern world and in Peru specifically (Biehler-Gomez et al. 2019; Villena 2015). Approximately 50% of foot amputations are attributed to the disease (Moulik et al. 2003), and it is known to have existed in antiquity (Dupras et al. 2010; Sanders 2002) outside of Peru.

Aside from diabetes, there are a number of other medical conditions that might have resulted in the removal of a foot. As noted in the introduction to this article, amputation is used in modern times as a treatment for trauma (Ahmad et al. 2019; Barla et al. 2017; Moini et al. 2009), circulatory and neuropathic issues (Nanwani et al. 2019), localized infections (Boffeli 2015), and necroses that result from frostbite or other factors (Zhao et al. 2020). Any of these conditions might be considered a potential precursor to amputation in the young adult women buried at Túcume, although necrosis that is specifically related to

frostbite should be considered extremely unlikely in the relatively warm coastal desert environment of Túcume. Congenital defects of the foot, such as club-foot, might also have been a reason for amputation (Wright 2011). However, unilateral congenital malformations of the foot would have likely caused developmental consequences for the lower limbs due to asymmetrical weightbearing during development. In both Case 1 and Case 2, aside from reduced cortical density of the bones of the left leg, the morphology of the right and left lower limbs is symmetrical. This would seem to indicate that differential use of the lower limbs did not occur until skeletal maturity.

The Case for Care

Regardless of the reason, or reasons, for amputation, changes to the distal tibiae and fibulae suggest that the individuals were still probably capable of locomotion (although locomotion might have been altered or required assistance). In both individuals, the slight loss of bone density in the affected left leg, as compared to the right leg, suggests a shift to preferred use of the right leg for supporting body weight. However, remodeling seems to have occurred in response to some force applied to the end of the left lower leg bones. This would appear to suggest that, while they were not using their left legs in a normal ambulatory fashion, the amputated limb might have contributed limited weight-bearing while standing, walking, or performing other activities.

It is worth noting that the individual from Huaca Las Balsas (Case 1) additionally demonstrates remodeling and pronounced thickening of the muscular attachment sites for the *adductor magnus* and *biceps femoris* muscles on the right femur (Fig. 9), possibly suggesting increased or irregular usage of the right leg. However, it is not clear if this change occurred as a result of biomechanical modification of the use of the lower limbs due to the amputation of the left foot. It could have also occurred separately due to another musculoskeletal injury.

Continued mobility after the amputation of the left foot could have involved the use of a crutch or prosthesis, which would have improved the efficiency of modified ambulation. Earlier Moche ceramic vessels depicting amputees often include crutches and cup-like coverings for amputated feet (Checa 2010; Paico Vélchez and Paico Zumaeta 2020; Urteaga-Ballon 1991; Vélez López 1913). Vélez López (1913) and Chauchat et al. (2009) describe prosthetics made of wood found in a Moche archaeological context. The fact that no such materials were recovered from the graves of the amputees at Túcume does not rule

out the possibility that they were used by these individuals during life. In fact, the asymmetrical cortical bone density of the humeri of both individuals could be a product of crutch use. Additionally, a wooden crutch or prosthetic might help to explain the termite activity in Case 2.

The unilateral amputation of a foot does not seem to have caused total immobility in the young adult females excavated from Huaca Las Balsas and Huaca Las Abejas (Case 1 and Case 2, respectively). However, it is important to acknowledge the long-term consequences of amputation-related physical limitations that affected the lives of those with missing body parts. In these cases, amputation would have affected gait efficiency and left the individuals relatively less mobile than unamputated community members. It is possible that they walked with an uneven gait and likely could not participate in fast-paced or physically strenuous ambulatory activities. With or without the use of a crutch or prosthesis, ambulation would have required greater-than-average energy expenditure, leaving them unable to easily transverse Túcume's urban core. Amputees might have relied on assistance and accommodation from community members for essential chores like food acquisition and other locationally tied economic exchanges. They also might have required assistance with pain management after the amputation procedure, which in itself would have required the attention of a person who had some level of practical anatomical knowledge and skill.

Unilateral amputation of the foot would not have prohibited these individuals from participating in typical gender-specific craft production activities, such as weaving, that do not involve strain on legs and feet. Cloth production would have probably afforded them some level of economic independence, in addition to their limited ambulatory independence with the use of a weight-bearing device. However, evidence of an amputation that was probably therapeutic in nature suggests that these individuals did, in fact, receive dedicated medical care at least once in their lives. Amputees likely relied on care and attention from kin, neighbors, and medical specialists during and after the surgery.

Modeling Care

Medical and emotional care for amputees

The lack of evidence for reduced social standing or greatly reduced quality of life after amputation in the two young adult females from Túcume suggests

availability of surgical care, societal accommodation of physical impairment, and possible involvement of kin-based support systems in physical and emotional post-operative care. These amputees were evidently able to access the expert medical care needed to perform amputation by disarticulation, possibly due to their elite social status or wealth. Additionally, skeletal remodeling suggests that they were provided with appropriate medical and general care after the surgical procedure (Buquet-Marcon et al. 2007; Van der Merwe et al. 2010; Zäuner et al. 2013).

The procedure itself would have required anatomical familiarity and skill in execution, suggesting that practitioners of amputation operated as knowledgeable medical specialists and probably held unique positions in society, such as healers or shamans (Mendoza 2003). The apparent disarticulation procedure that was performed at least twice during different time periods at Túcume would have likely been executed similarly to a modern-day Syme amputation, which involves cutting a fish-mouth incision around the ankle joint so that the tarsal bones can be easily accessed and pulled apart (Yu and Hudson 2001). The fatty flesh of the heel pad is later used to cover the end of the newly footless ankle.

In addition to the disarticulation of the ankle joint, the Syme procedure typically also involves the resection of the malleoli of the tibia and fibula (Yu and Hudson 2001), creating a more solid weight-bearing surface. Neither of the cases discussed here show intentional removal of the malleolar portions, and clefted stubs depicted in Moche representations of amputees suggests this was not common practice on the Peruvian north coast in preceding centuries (Verano et al. 2000). Despite this inconsistency, the Syme procedure provides what is probably the best baseline for estimating pre-Hispanic amputation methodology.

A healer or shaman performing an amputation would have needed at least a basic understanding of how to stop bleeding during and immediately after the procedure. This might have been achieved through tourniquets, limb elevation, and/or bandaging, as has been done historically in other parts of the world (Kirkup 2007). Blood loss could also have been reduced with the use of local plant-based remedies for bleeding and hemorrhaging (Bussmann and Sharon 2006, 2015). Finally, cauterization or suturing might have been used to close the wound. Precedent for such practices exists elsewhere in the pre-Hispanic Andes (Cabieses Molina 2007; Mendoza 2003; Moodie 1929; Toyne 2015b).

Appropriate administration of naturopathic anesthetic and pain-relieving drugs (Bussman and Sharon 2006, 2015; Martin 1970) would have greatly

benefitted patient comfort during and after the surgical process. Other necessary short-term post-operative care would have included wound hygiene and provision of food and water when the physical exertion required for self-care would have resulted in excessive pain or disruption to healing tissues. It would have likely involved changing bandages and administering anti-inflammatory and/or infection-fighting drugs as well (Kirkup 2007; Pullen 2010). Some endemic plant species are used by local people in the modern day to ward off bacterial, viral, and parasitic infection, and these plants were likely used for the same or similar purposes in the distant past (Bussmann and Sharon 2006, 2015).

Another probable responsibility of ancient amputees' caretakers was to aid in their efforts to relearn basic skills, such as walking (Kirkup 2007). Although rehabilitation after a unilateral Syme amputation is less challenging than doing so after an amputation procedure that more dramatically alters the limb, the amputees from ancient Túcume likely felt imbalanced and required interpersonal assistance while they adjusted to their new reality (Finkler et al. 2017). Assistance could have been given by people of close relation to the amputees, such as members of their immediate family. However, this is speculative. Short-term post-operative care might have also been performed by medical practitioners or other community members.

Naturopathic treatments for pain and discomfort also probably played a role in amputees' long-term care routines. The bichayo plant, for example, whose seeds were found in the burial context of the amputee from Huaca Las Abejas (Case 2), can serve as a remedy for arthritis, bone aches, and skin irritations (Bussmann and Sharon 2015:127). Its presence in the grave of this individual could suggest that the plant became associated with her identity after frequent use, possibly as a solution to joint pain caused or exacerbated by habitual compensatory movements after loss of the left foot. Use-related migration of the heel pad and subsequent ulceration (Bibbo 2013) or the cyst-like structure present at the amputated ankle joint might also have been a cause of discomfort that the amputee and her caretakers attempted to treat through the use of bichayo. Heel pad migration and ulceration are common in modern amputees whose feet were removed via the Syme procedure, in which the fatty heel pad is used to cover the newly footless ankle stub (Bibbo 2013), but it is unclear whether or not the surgeons of pre-Hispanic Túcume used the heel pad to cover the amputation wound.

Ultimately, it is important to note that the care necessary during post-amputation life includes physical as well as emotional support. Studies of

contemporary amputees show that amputation of lower extremities not only causes physical trauma, but also emotional and psychological damages. Patients often suffer from anxiety, depression, grief, and social discomfort associated with changes to body image (Liu et al. 2010; Madsen et al. 2016). Historically, these same post-amputation physical and psychological struggles were documented in civil war soldiers recovering from amputation as they attempted to come to terms with new limitations in functionality and shifts in their social identities (Bonnan-White et al. 2016; Miller 2015). It is impossible to know the emotional struggles of individuals who lived in the distant past, especially in societies not represented by written histories, but it is important to recognize that lived experiences encompass more than solely physical events. The social circles of the amputees from Huaca Las Balsas and Huaca Las Abejas likely provided important emotional support.

Implications of Care

Social integration of amputees

Despite physical impairment and its emotional consequences, it is important to consider the fact that individuals affected by unilateral foot amputation might not have been classified as disabled within the societal norms of Late Intermediate Period and Late Horizon Túcume. Some modern scholars studying the anthropology of disability choose to make a clear distinction between impairment and disability, with disability being defined as the social stigma that is associated with psychological or physiological impairment or malformation (Kasnitz and Shuttleworth 2001). Ethnographic research on disability in a number of modern cultures has revealed that impairment-related stigma is not applied according to universal standards.

Atypical functional phenotypes are sometimes even seen as supernatural or sacred. Rösing (1999), for example, relates several anecdotes of physical impairments in the modern Andes that suggest recognition of disability is dependent on an impaired individual's community contribution, and in some cases (such as those involving medicine men with crippled hands) impairment might actually be viewed as sacred. She presents the hypothesis that: "In the Andes having more disablement often means being less disabled. The reasons are, amongst others, the broader space allowed for compensation within the framework of the norms of reciprocity and representation, as well as the sacred legitimization resource" (Rösing 1999:40).

The distinction between impairment and stigmatized disability provides some interpretive implications related to burial practice and social identity. Social exclusion based on physical impairment could result in deviant burial—a burial style that deviates from the typical model (Murphy 2008; Shay 1985). In the Andes, deviancy is often argued through atypical body treatment, separate burial location, lack of associated burial goods, or some combination of these characteristics. Most examples of deviant burial in Peru have been associated with sacrifice and warfare (Eeckhout and Owens 2008; Verano 1995). Although deviant burials of human sacrifices are found near the Temple of the Sacred Stone at Túcume (Toyne 2015a, 2016), burials of this character have not been found elsewhere at the site.

The amputees at Huaca Las Balsas and Huaca Las Abejas were seemingly not stigmatized for their lost left feet. All indications in the mortuary record point toward a conclusion of social normativity rather than social deviancy for these young female amputees. In fact, it is possible that they might not even have been considered disabled. The apparently high level of social integration experienced by these individuals suggests that they were not outcasts or criminals whose left feet were removed for punitive purposes, despite the depictions of amputees in Moche ceramics that seem to suggest punishment as one potential motivation of amputation (Vélez López 1913; Verano et al. 2000). Instead, they were probably individuals with unexceptional social positions and reputations whose feet were amputated as treatment for a medical condition.

Pre-Hispanic amputation as social practice

The amputations discussed in this paper might have had a ritual or sacred significance due to earlier depictions of feet and individuals with amputated feet by Moche and Wari ceramic vessels, which suggest symbolic importance of the lower extremities. Such a conclusion could also be supported by the presence of footless guardians in grand Moche (Alva and Donnan 1993; Verano 1997) and Wari (Więckowski 2016) tombs. However, while valid parallels can be drawn between pre-Lambayeque art, pre-Lambayeque mortuary symbolism, and the chronologically later amputation cases at Túcume, there is not a consistent pattern for ritually motivated amputation in these cases.

Andean gendered cosmologies could also be used to construct an argument for ritually or symbolically motivated foot amputation at Túcume, although this is not strongly supported by contextual evidence. The dualistic gendered symbolism

of Andean cosmology denotes parallelism and complementarity that is reflected in religious and political practices (Silverblatt 1987; Vogel 2018). Therefore, pre-Hispanic Andean religious rituals often involved separate but parallel spatial organization within sacred spaces (Silverblatt 1987). This included the body. In pre-Hispanic Andean cosmology, the left side of the body and the feet were often characterized as feminine, while the right side and head were characterized as masculine (Baumann 1996). The appearance of two young adult women of similar social standing with left-side foot amputations at Túcume could potentially indicate a gendered ritualistic practice. However, other known cases of pre-Hispanic pedal amputation on the Peruvian north coast are inconsistent with this pattern (Table 1). At other sites, male individuals are found with bilaterally or unilaterally amputated right and left feet, as are females (Chauchat et al. 2009; Vélez López 1913; Verano et al. 2000; Więckowski 2016).

This research, in concert with the amputation cases published by Verano et al. (2000) and Chauchat et al. (2009), show that non-symbolic amputations occurred in pre-Hispanic north coast Peru. Motivations for foot removal were likely diverse, and medicine might not have been the only reason that these surgeries were performed. Nonetheless, there do appear to be some shared characteristics between amputees. All presently known cases of amputation in the ancient Andes have been identified on the north coast of Peru, all have occurred in individuals who survived the procedure to die as adults, and all seem to have been buried as relatively high-status people (or were buried alongside them). This evidence suggests that amputation-related medical knowledge has deep roots in earlier cultures. Also, access to medical care such as amputation might have been an elite privilege that was not accessible to people of lower status.

Conclusion

The medical history and post-amputation care practices of the young adult females with amputated left feet found at Huaca Las Balsas and Huaca Las Abejas provide new evidence for medical knowledge, societal conceptions of functional impairment and disability, and broader patterns in amputation in pre-Hispanic north coastal Peru. This research demonstrates that pedal amputation via disarticulation at the ankle joint has an even longer and more dynamic regional history than has been previously published.

The Lambayeque and Chimú-Inca amputees from Túcume illustrate a regional continuity of medical knowledge that transcends major sociopolitical disruptions and power transitions over hundreds of years between Moche regional dominance and the arrival of the Spanish. Additionally, the evidence shows that amputation had a multidimensional and perhaps contextually specific social significance in Lambayeque and later cultures of the Peruvian north coast. While past bioarchaeological and ceramic evidence has suggested that amputation was used for punitive and symbolic reasons, amputation at Túcume seems to have been a primarily therapeutic practice. These female foot amputees appear to have been integrated members of society who were able to access advanced surgical care and then survive for years afterward—through care and accommodation by community members—without severe social stigmatization despite newly limited physical functionality.

This research sheds new light on amputation as a community practice in pre-Hispanic north coast Peru. However, perhaps more importantly, it lends new temporal and cultural depth to broader anthropological understandings of functional impairment and healthcare. The experiences of elite-status amputees at Túcume should fuel further thought about the ways in which class status, community support, and other variables affect medical care and social accommodation for functionally impaired people.

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