Violence and Weapon-Related Trauma at Puruchuco-Huaquerones, Peru

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ABSTRACT Conquest of indigenous peoples in North America is understood primarily through ethnohistorical documents, archaeological evidence, and osteological analyses. However, in the Central Andes, the colonial enterprise and its effects are understood only from post-contact historical and ethnohistorical sources. Few archaeological and bioarchaeological studies have investigated Spanish Conquest and colonialism in the Andean region [for exceptions see Klaus and Tam: Am J Phys Anthropol 138 (2009) 356–368; Wernke, in press; and Quilter, in press]. Here we describe bioarchaeological evidence of violence from the cemeteries of Huaquerones and 57AS03 within the archaeological zone of Puruchuco-Huaquerones, Peru (circa A.D. 1470–1540). A total of 258 individuals greater than 15 years of age were analyzed for evidence of traumatic injuries. Individuals were examined macroscopically and evidence of traumatic injuries was analyzed according to the skeletal element involved, the location of the injury on the skeletal element, and any additional complications of the injury. This study examines and compares the evidence of perimortem injuries on skeletonized individuals from the two cemeteries and focuses specifically on the interpretation of weapon-related perimortem injuries. Evidence of perimortem trauma is present in both cemeteries (18.6%, 48/258); however, the frequency of injuries in 57AS03 is greater than that in Huaquerones (25.0% vs. 13.0%). Several injuries from 57AS03 are consistent with documented cases of injuries from firearms and 16th Century European weapons. We believe that the nature and high frequency of perimortem trauma at 57AS03 provide evidence of the violence that occurred with Spanish Conquest of the Inca Empire. Am J Phys Anthropol 000:000–000, 2010.

Historical sources describe repressive and extreme forms of violence during the Spanish Conquest of the Americas. Despite long-term research on the biocultural effects of European contact on indigenous communities in the Americas (Verano and Ubelaker, 1992; Larsen, 1994; Larsen and Milner, 1994; Baker and Kealhofer, 1996; Larsen et al., 2001; Klaus and Tam, 2009; Spielmann et al., 2009), evidence of the historical battles or skirmishes of the Spanish conquest of indigenous populations has proven elusive (Larsen, 1994). Only two cases of osteological evidence for violent conflict at or shortly after Spanish conquest are known from North America (Hutchinson, 1996; Larsen et al., 1996). At Tatham Mound, Hutchinson (1996, 2009; p. 60) found evidence of sharp force injuries from metal-edged weapons that are likely associated with De Soto's 1539 expedition (Hutchinson, 1996, 2009). The second case of violence associated with Spanish conquest is from Mission San Luis de Tamli (A.D. 1656–1704) in La Florida, where a 0.44-calibre lead shot was discovered in the lumbar region of an adult male (Larsen et al., 1996). No injuries from the shot were detected on the skeleton and the authors conservatively maintain that either natives or Spanish could have wielded the firearm (Larsen et al., 1996; p. 43). Bioarchaeological investigators in the Southwest find increased evidence of traumatic injuries after Spanish conquest, particularly among males, which is believed to be associated with both native versus Spanish violence and interpueblo violence (Stodder and Martin, 1992), but injuries inflicted by European metal edged weapons or firearms have not yet been reported. In Andean South America, few researchers have investigated contact era samples and evidence of injuries associated with violent encounters with the Spanish and conquest has not been reported. Here we describe and compare the nature and pattern of perimortem trauma from two cemeteries within the archaeological zone of Puruchuco-Huaquerones. We explore the perimortem injuries from weapons within the context of Spanish conquest of the Inca Empire (~circa 1532) and present what we believe is some of the first physical evidence from Andean South America of violent confrontation with the Spaniards.

Additional Supporting Information may be found in the online version of this article.

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SPANISH AND INDIGENOUS WARFARE AND WEAPONS

Spanish conquest and invasion brought violence, repression, and the introduction of new epidemic diseases, followed by territorial occupation, religious persecution and evangelization, and Spanish imperial rule to the Central Andes (Rowe, 1957; MacCormack, 1991; Stern, 1993; Del Busto Duthurburu, 1966, 1978a; Abercrombie, 1998; Cook, 1998; Spalding, 1999; D'Altroy, 2002). Although Spanish Conquest of the Inca Empire has been perceived as swift and inevitable, the Spanish did not completely control the lands of the Inca empire for nearly 40 years (Rowe, 1957, 2006). After the first violent encounter when the Spanish ambushed the newly victorious ruler, Atahualpa, and his thousands of forces in Cajamarca, other battles and skirmishes were reportedly fought during the first several years of the Spanish invasion, and two Inca uprisings occurred in 1536—one in Cusco and one in the new Spanish capital established in Lima (Del Busto Duthurburu, 1978a; Guaman Poma, 1980; Vega, 1980; Cieza de León, 1985; Rostworowski, 1999; D'Altroy, 2002).

Spanish military tactics and weapons were unlike those practiced and used by the Incas and other prehispanic peoples. The Inca army was only partially composed of a warrior class (usually Inca nobility), but all adult males served in the Inca army as part of their labor service to the Inca state (Rowe, 1946; Hemming, 1970; Cobo, 1979 [1653]; D'Altroy, 2002). Typically Inca warriors trained for and engaged in hand-to-hand combat (Sarmiento de Gamboa, 1999 [1572]) and they were armed with a diversity of both long- and short-range weapons (Rowe, 1946; D'Altroy, 2002). The Inca armaments included different clubs and maces, slings with sling stones, large axe-like implements, bolas, *tumi* knives, and large wooden spears (*macana*) (Rowe, 1957; Del Busto Duthurburu, 1978b; Himmerich y Valencia, 1998; D'Altroy, 2002). The Inca attached edges or points made of animal bone, copper, silver, or bronze to their weapons (Rowe, 1946; Salas, 1950; Hemming, 1970; Pizarro, 1978; Himmerich y Valencia, 1998; D'Altroy, 2002). As armor, the Incas donned lightweight cotton or textile padding.

The Spanish terrorized and massacred indigenous peoples with horses, dogs, firearms, and a variety of weapons, but it is likely that the conquistadors and their troops used whatever weapon was available (Salas, 1950; Lockhart, 1972; Varner and Varner, 1983; Guilmartin, 1991). According to historical sources, the steel sword was viewed as the most lethal and powerful weapon (Salas, 1950; Guilmartin, 1991). Other piercing and slashing weapons with steel blades were also common and included pikes, polearms, and lances (Salas, 1950; Guilmartin, 1991). The crossbow was likely part of the armaments, but it was heavy and was usually reserved for long-range purposes against enemy cavalry in Europe, rather than against the foot soldiers comprising the Inca troops (Salas, 1950; Guilmartin, 1991). There is some historical evidence that the crossbow was used against infantry forces (Nicolle, 1999), but its use has not been described extensively in the Andean region. Spanish armaments could have included the longbow, as they have been recovered from other 16th century archaeological contexts (see Gardiner, 2005). The firearms available to the Spanish at the time included the arquebus and some pistols, but these were too clumsy, unpredictable, and too inaccurate to be used preferentially (Guilmartin, 1991; Salas, 1950). Historical accounts of the capture of Atahualpa in Cajamarca describe the Spanish firing a small cannon, or falconet, to frighten the Incas (Hemming, 1970), but it was not heavily used in the conquest of the Incas (Salas, 1950; Guilmartin, 1991). At the beginning of conquest, supplying these firearms with projectiles likely presented some challenges and the Spanish developed different strategies when the lead musket balls were in short supply, such as loading rocks or other metal objects into their firearms and small cannons (Salas, 1950; Guilmartin, 1991). The Spanish were also known to join two spherical lead halves with a wire that were released when the firearm was discharged, a particularly lethal projectile called wire balls or "branched" balls (Salas, 1950; p. 211–212).

Research directed at questions of prehispanic violence and trauma on scientifically excavated archaeological samples from South America has flourished in recent years (Kellner, 2002; Verano, 2003a,b, 2008; Torres-Rouff and Costa Junqueira, 2006; Andrushko, 2007; Tung, 2007; Standen et al., 2009; Klaus et al., in press). These recently conducted studies permit comparative research across different geographic regions and from different time periods that give us a richer view of violence, warfare, and the types of injuries that may have resulted from prehispanic weapons. Although few bioarchaeological investigations of the effects of 16th century and late medieval European weaponry have been conducted, a growing corpus of experimental and historical work on the effects of these weapons holds promise for ongoing and future investigations (Ingelmark, 1939; Boylston, 2000; Novak, 2000; Hutchinson, 2009).

MATERIALS AND METHODS

The archaeological zone of Puruchuco-Huaquerones is located on the Central Coast of Peru approximately 12 km southeast of the center of Lima in the middle of the Rímac valley (Fig. 1). Cobo (1979 [1653]) reports the presence of the Incas on the central coast circa A.D. 1470. Inca architectural influences are present among some of the buildings at Puruchuco-Huaquerones and 21 Inca khipus (knotted string recording devices) have been recovered (Tabio, 1965; Villacorta, 2004; p. 553; Urton and Brezine, 2005).

The archaeological zone contains several cemeteries, two of which, Huaquerones and 57AS03, are contemporaneous and located less than a mile from one another. Increasing urbanization and development into the area impacted these sites and necessitated the salvage excavations by Guillermo Cock and Elena Goycochea. The presence of Inca-style ceramic vessels, a small number of Early Colonial ceramic vessels, as well as Inca stylistic patterns and details on textile bags, date the burials to the arrival of the Inca in the Rímac valley until shortly after the arrival of the Europeans, or approximately A.D. 1470–1540 (Cock and Goycochea, 2004; p. 185; Cock, 2006).

For this study, a total of 519 individuals were examined from Huaquerones and 57AS03 and most of them were complete from intact Late Horizon contexts (Fig. 2), but some were from disturbed contexts, a small number from Huaquerones are Early Colonial and a sample from 57AS03 depart from the Late Horizon pattern. The mortuary patterns for the Late Horizon adult burials are

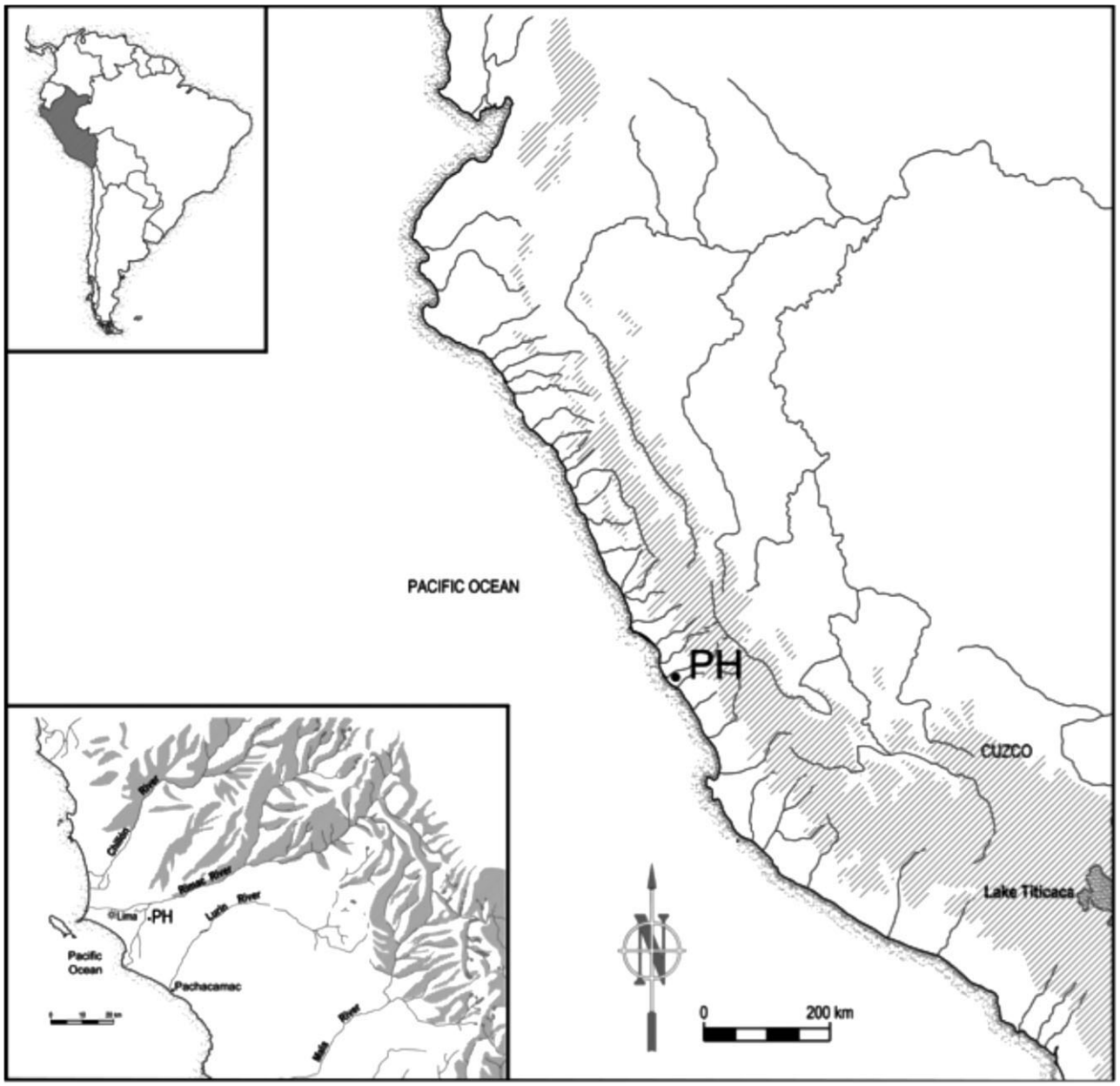

Fig. 1. Map of the location of Puruchuco-Huaquerones, Peru. See also Supporting Information for a map of the location of Huaquerones and 57AS03 in the archaeological zone.

very similar in the two cemeteries with an individual interred in a seated and flexed position facing the northeast and wrapped in textile bundles (Cock and Goycochea, 2004; Cock, 2006). Mortuary offerings included textiles, ceramics, musical instruments, weaving implements, beans, corn, gourds, thorny oyster shells or other shells, textile bags, and metal tweezers (Cock, 2002; Cock and Goycochea, 2004). The mortuary contexts from Huaquerones exhibit evidence of social differentiation, as some of the contexts are more elaborate, with larger bundles, higher quality offerings, and more numerous offerings. A subset of the Huaquerones burials possess false-heads on their textile bundles and likely represent the individuals who received the most preparation and elaboration (see Cock 2002, Cock and Goycochea 2004). A sample of burials from 57AS03 departs from the typical Late Horizon mortuary pattern in preparation, elaboration, position, and orientation. These burials are not oriented to the northeast and the principal individuals were recovered in supine and prone positions, semiflexion or a combination of positions. The burials usually lack mortuary offerings or possess very few, and often only have one or two textile wrappings. They are also located at the more superficial levels of 57AS03 and at the peripheries of the cemetery. Based on these observations, Guillermo Cock and Elena Goycochea hypothesized that these burials were interred after the Late Horizon and that they might represent early contact period burials that were hastily prepared and interred, but without the protracted Late Horizon mortuary preparation and before the implementation of Christian burial practices.

Fig. 2. Example of intact Late Horizon burial from Puruchuco-Huaquerones.

TABLE 1. Sample composition from Puruchuco-Huaquerones by age, sex, and burial type

	Huaquerones	57AS03	Total
Total	321	198	519
>15 yr of age	138	120	258
Males	72	60	132
Females	58	47	105
Indeterminate	8	13	21
Late Horizon	105	43	148
Atypical	0	69	69
Indeterminate	23	8	31

Of the 519 individuals, 321 were from the Huaquerones cemetery and 198 from 57AS03 (Table 1). For intersample comparability (following Milner et al. 1991; Jurmain et al. 2009; Steadman 2008), this study focuses on the traumatic injuries for individuals 15 years of age and older (N = 258; Table 1). In the sample of individuals >15 years of age (N = 258), 132 were male, 105 were female, and 21 were of indeterminate sex.

Methods of age and sex estimation were based upon established protocols (Buikstra and Ubelaker, 1994; White, 2000; Bass, 2005). Adult age estimation was based upon age-related changes to the morphology of the pubic symphysis, the auricular surface, and the sternal end of the rib (Lovejoy et al., 1985; Buikstra and Ubelaker, 1994; Bass, 2005). Sex determination was based upon characteristics of the pelvis and the cranium (Meindl et al., 1985; Buikstra and Ubelaker, 1994).

In the trauma analysis, individuals were examined macroscopically and evidence of traumatic injuries was recorded by the skeletal element, by the location of the injury on the skeletal element and by any additional complications of the injury (Buikstra and Ubelaker, 1994; Lovell, 2008). The shape, location, and size of injuries were also recorded. While it is difficult to differentiate perimortem injuries from postmortem damage on archaeological assemblages of human skeletal remains, conservative attempts were made to establish the timing of the injuries based on osseous evidence and burial context (Berryman and Haun, 1996; Berryman and Symes, 1998; Sauer, 1998; White, 2000). Antemortem injuries were identified by the presence of new bone formation and evidence of healing and remodeling (after Sauer, 1998). In contrast, perimortem injuries were identified by the absence of healing and the absence of the formation of new bone (Sauer, 1998). Since dried bone fractures differently than fresh bone, the edges of perimortem fractures are typically more irregular than the edges of postmortem fractures (Sauer, 1998; Sledzik, 1998). The presence of plastic deformation at or near the fracture margins was used to distinguish perimortem injuries (Berryman and Haun, 1996; Sauer, 1998; Sledzik, 1998; Lovell, 2008). Curling, splintering, and chatter may also be evident on perimortem injuries (Sauer, 1998: 325). Differential staining and coloration was also used to distinguish perimortem injuries from postmortem damage, as newly exposed bone will often be lighter in color (Sauer, 1998). Ground pressure and postmortem damage can mimic perimortem injuries, and in these instances, the archaeological and burial contexts may provide insights into the timing and mechanism of injuries.

Using characteristics reported in published studies, we attempted to identify the mechanism of injury and classify the injuries accordingly. We identified cases of blunt force trauma based on the presence of plastic deformation at fracture margins, inbending at the site of impact and outbending at the periphery, radiating fractures from the point of impact, concentric fractures that run perpendicular to the radiating fractures, and delamination and knapping or flaking at the borders (with multiple blows) (after Berryman and Symes, 1998: 340-342; Galloway et al., 1999; and Williamson et al., 2003). Firearm trauma was identified on the basis of the presence of projectile entrance and exit wounds, internally beveled entrance wounds, externally beveled exit wounds, radiating fractures from entrance and exit wounds, concentric heaving fractures beveled externally, and secondary concentric fractures (Berryman and Symes, 1998; DiMaio, 1999). Since bullet wipe can also be detected macroscopically, microscopically, and radiologically (Berryman and Symes, 1998; DiMaio, 1999), suspected cases of firearm trauma were also radiographed to detect metal residues. Sharp force trauma was identified on the presence of cut or stab wounds, incisions, parallel striations along the cut area, shaving, and hinging, with some injuries also presenting with characteristics of blunt force trauma (e.g. hacking trauma) (Hutchinson, 1996; Humphrey and Hutchinson, 2001; Tucker et al., 2001; Symes et al., 2002; Williamson et al., 2003). Numerous archaeological examples of injuries from bladed or metal edged implements, such as swords, have been published (for examples, see Ingelmark, 1939; Anderson, 1996; Hutchinson, 1996; Novak, 2000; Weber and Czarnetzki, 2001; Williamson et al., 2003; Mitchell

TABLE 2. Perimortem trauma by cases and individuals in both cemeteries

	Huaquerones	57AS03	TOTAL
Cases (cranium + postcranium)	24	167	191
Individuals	18 (13.0%)	30 (25.0%)	48 (18.6%)
Males	12	19	31
Females	6	9	15
Indeterminate	0	2	2
Cases (cranium)	13	40	53
Individuals	13 (9.4%)	21 (17.5%)	34 (13.2%)
Males	9	13	22
Females	4	7	11
Indeterminate	0	1	1
Cases (postcranium)	11	127	138
Individuals	6 (4.4%)	18 (15.0%)	24 (9.3%)
Males	4	14	18
Females	2	4	6
Indeterminate	0	0	0

TABLE 3. Perimortem trauma by individuals

Burial number	Age	Sex	Burial type	Description of perimortem trauma
HP01-11	35–49	M	Late Horizon	Majority of cranium
HP01-32	20–34	M	Late Horizon	Right frontal
HP01-33	15–20	M	Late Horizon	Majority of left side of cranium, right mandible
HP01-39	20–34	F	Late Horizon	Right rib 3
HP01-76	15–20	F	Late Horizon	Left side and midline of cranium (parietal, occipital)
HP01-83	35–49	F	Late Horizon	Left rib 2
HP01-84	35-49	M	Late Horizon	Majority of cranium
HP01-86	20–34	M	Late Horizon	Occipital
HP01-107	35–49	M	Late Horizon	Right parietal, right temporal
HP01-109	20–34	M	Late Horizon	Right rib 5, right rib 7
HP01-115	20-34	M	Late Horizon	Left rib 1
HP01-123	20–34	M	Late Horizon	Mandible
HP01-126	20-34	F	Late Horizon	Multiple rib fractures (5)
HP02-170	20–34	M	Late Horizon	Majority of cranium, right rib
HP02-174	20–34	M	Late Horizon	Majority of right side of cranium
HP02-187	20–34	F	Indeterminate	Majority of cranium
HP02-193	16–18	I	Late Horizon	Left parietal
HP02-199	16–18	F	Late Horizon	Mostly to left side of cranium, some damage on right side
57AS03E031A	35–49	M	Late Horizon	Left patella and left tibia
57AS03E048	15–20	F	Atypical	Left parietal
57AS03E073	20–34	M	Atypical	Extensive damage to left side of cranium, occipital
57AS03E081	20–34	M	Atypical	Left tibia
57AS03E097	15–20	M	Atypical	Multiple rib fractures
57AS03E107	20–34	F	Late Horizon	Multiple injuries to cranium (frontal, mandible), 6^{th} thoracic vertebra
57AS03119A	35–49	F	Atypical	Injuries to right frontal, zygomatic, sphenoid, and maxilla and multiple rib fractures
57AS03E121	20–34	M	Atypical	Extensive damage to entire cranium
57AS03E123	20–34	M	Atypical	Projectile entrance and exit wounds; related damage to cranium
57AS03E127	50+	M	Atypical	Multiple rib fractures, right fibula
57AS03E145	15–20	F	Atypical	Occipital, right parietal
57AS03E160	20–34	M	Atypical	Craniofacial region, occipital, right scapula, right radius, right 4^{th} metacarpal, right fifth metacarpal
57AS03E164	35–49	F	Atypical	Left scapula, multiple rib fractures
57AS03E175	35–49	M	Atypical	Maxillae and mandible, Left rib 9, sternum, multiple injuries to pelvis
57AS03E176	50+	F	Atypical	Extensive damage to cranium
57AS03E185	35–49	M	Atypical	Multiple rib fractures
57AS03E189	20–34	M	Late Horizon	Rib fractures, multiple injuries to right scapula
57AS03E218	20–34	M	Atypical	Occipital
57AS03E231	15–20	F	Atypical	Ovoid defect to left frontal; extensive damage to entire cranium
57AS03E241	15–20	F	Atypical	Left and right femora
57AS03E248	15–20	M	Atypical	Quadrangular defects to left, posterior of cranium; left rib 1, left third and fourth metacarpals, right proximal tibia
57AS03E269	15–20	M	Atypical	Left clavicle
57AS03E275	35–49	M	Atypical	Right rib 2
57AS03E366	35–49	F	Atypical	Left temporal, parietal
57AS03E368	35–49	M	Atypical	Mandible, atlas, multiple rib fractures, manubrium
57AS03E449	35–49	M	Atypical	Frontal, left maxilla
57AS03E450	20–34	M	Late Horizon	Multiple rib fractures, manubrium, sternum, left clavicle
57AS03E459	20–34	M	Atypical	Occipital, right radius
57AS03E474	15–20	M	Atypical	Multiple rib fractures, left and right scapulae, right radius
57AS03E479	15–20	I	Atypical	Extensive damage to entire cranium

TABLE 4. Individuals with perimortem injuries by burial type

	Huaquerones (N = 138)	57AS03 (N = 120)	Total
Late Horizon	17/105 (16.2%)	4/43 (9.3%)	21/148 (14.2%)
Atypical	0/0 (0.0%)	26 /69 (37.7%)	26/69 (37.7%)[a]
Indeterminate	1/23 (4.3%)	0/8 (0.0%)	1/31 (3.2%)
Total	18/138	30/120	48/258 (18.6%)

[a] Statistically significant differences in frequency of perimortem trauma between atypical and Late Horizon burials ($P \leq 0.001$).

et al., 2006; Owens, 2007; Paine et al., 2007; Jiménez-Brobeil et al., 2009).

To discern injury patterns, the injuries were classified and analyzed by individual and demographic information (age and sex), by anatomical side, and by skeletal elements most frequently affected. In the calculation of total number of skeletal elements, individual elements were only counted if more than 50% of the element was present. Injuries to particular skeletal elements were also further analyzed to assess underlying etiology and to reconstruct behavior patterns (Walker, 1989, 1997; Judd, 2008).

Fig. 3. Blunt force trauma to the left parietal of a young adult female (Burial 48) from 57AS03. Note the point of impact (arrow), the radiating fractures, and the concentric fractures. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

RESULTS

Perimortem trauma

Evidence of perimortem trauma was present in the combined sample from both cemeteries (18.6%, 48 of 258); however, the frequency of injuries in 57AS03 was nearly twice that of Huaquerones (25.0% vs. 13.0%, Tables 1–3). In both cemeteries, males exhibited higher rates of perimortem injuries than females (Huaquerones = 12 vs. 6; 57AS03 = 19 vs. 9) and they exhibited higher rates of perimortem trauma to the cranium than females. Only the differences in frequency of the postcranial perimortem injuries between males and females at 57AS03 were statistically significant ($\chi^2 = 5.55$, d$f = 1$, $P \leq 0.05$). In the total sample, the frequency of perimortem trauma was higher among the atypical burials than in the Late Horizon burials (37.7% vs. 14.2%, Table 4) and these differences are statistically significant ($\chi^2 = 15.31$, d$f = 1$, $P \leq 0.001$).

Cranial injuries. Approximately 13.2% of the combined sample from Puruchuco-Huaquerones (34 of 258) showed perimortem injuries to the cranium. From 57AS03, a total of 21 individuals, or 17.5% of the sample of 120 individuals, exhibited perimortem trauma to the cranium (vs. 9.4% in Huaquerones). The majority of these cases from both cemeteries were consistent with injuries inflicted by blunt force objects, where the point of impact, radiating fractures, and concentric fractures could be identified (Berryman and Haun, 1996; Berryman and Symes, 1998) (Fig. 3). In this particular case, four fractures radiate from the point of impact on the left parietal and concentric fractures surround this area. Plastic deformation and delamination are present on the fracture margins. The force of the blow was sufficient to cause one fracture to radiate across the sphenoid, just anterior to the sella turcica, and across the palate to right external auditory meatus, and ending at the right squamosal suture. The mandible also possesses a parasymphyseal perimortem fracture to the right of the mental symphysis and a perimortem fracture to the left condyle.

Several individuals from 57AS03 exhibited perimortem injuries consistent with European weaponry, including sharp force trauma, and possible firearm trauma (described in greater detail below). In the Huaquerones sample, most of the perimortem injuries were sustained on the posterior of the cranial vault, but many injuries were extensive and affected both the anterior and posterior portions of the vault. A preponderance of perimortem injuries occurred on the anterior aspect and the left side of the vault in the sample from 57AS03. These differences between the anterior and posterior portions of the vault were not statistically significant and many injuries were extensive and affected multiple areas of the cranium.

Postcranial injuries. Eighteen individuals (15.0%) from 57AS03 exhibited perimortem trauma to the postcranial skeleton (Tables 2–4). Males had more perimortem injuries to the postcranium than females in both Huaquerones and 57AS03, but this difference was only statistically significant at 57AS03 (14 males, four females; $\chi^2 = 5.55$, df = 1, $p \leq 0.05$). At 57AS03, the most frequently fractured postcranial elements were ribs, followed by the scapula, and then the radius/tibia (Table 5). Eighteen individuals had multiple perimortem injuries, including multiple rib fractures, rib fractures and cranial trauma, or rib fractures with fractures to other elements of the axial skeleton (e.g. scapula, clavicle, manubrium). At 57AS03, males were more likely to show multiple perimortem injuries. Three individuals displayed multiple rib fractures without accompanying perimortem injuries to other skeletal elements. The frequency of perimortem injuries to the postcranial skeleton was lower at Huaquerones, with only six individuals showing these injuries (4.4%, four males, two females). All of the postcranial perimortem injuries from Huaquerones affected only the ribs and no other postcranial skeletal element was observed with perimortem trauma (Table 4).

Weapon related perimortem injuries. In addition to the different pattern of perimortem injuries from the two cemeteries, several individuals from 57AS03 showed weapon related perimortem injuries that are consistent

TABLE 5. Perimortem trauma by skeletal element

	Huaquerones		57AS03	
Element	Total elements	Perimortem (% of total)	Total elements	Perimortem (% of total)
Cranium	129	13 (10.1)	99	40 (40.4)
Clavicle	245	0	203	2 (1.0)
Scapula	241	0	203	8 (3.9)
Sternum	115	0	102	2 (2.0)
Innominate	249	0	204	2 (1.0)
Ribs	2,847	11 (0.4)	2382	98 (4.1)
Humerus	189	0	207	0
Radius	180	0	196	3 (1.5)
Ulna	178	0	193	0
Femur	176	0	203	2 (1.0)
Tibia	173	0	199	2 (1.0)
Fibula	175	0	199	1 (0.5)

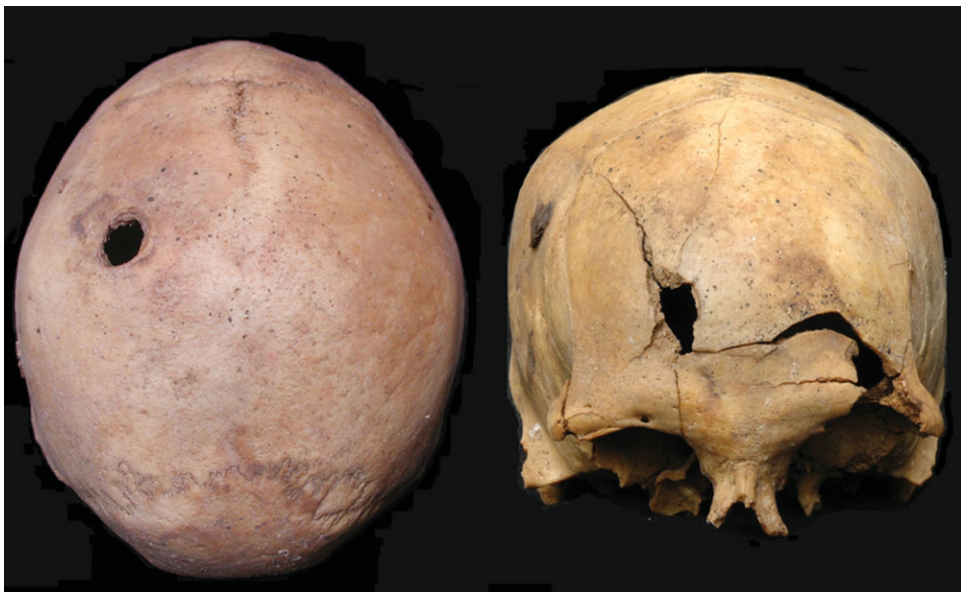

Fig. 4. Left, superior view of Burial 123 with ovoid defect consistent with a perimortem penetrating injury, possibly a projectile entrance wound. Right, perimortem damage to frontal of Burial 123 with a small defect, an area of possible external beveling, and several radiating fractures. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

with European weapons used at the time of Spanish Conquest. Burial 123 had a circular injury on the left parietal that measured 15.5 mm in the anterior-posterior dimension and 17.1 mm in the mediolateral dimension (Fig. 4). The interior of the injury displayed de-lamination of the inner table of the endocranium and a plug of bone was recovered among the facial bone fragments (Fig. 5). The ectocranial surface of this plug of bone is slightly compressed, but no impact points are present. The endocranial surface of the plug has four hairline fractures that radiate from the center and towards the edges of the plug (Fig. 5). Burial 123 has a defect on the right frontal that has some delamination and possible external beveling and several fractures originate and radiate from this defect (Fig. 4). The anterior vault, the facial region and the mandible of Burial 123 have extensive fracturing and damage and most of these areas could not be reconstructed, which posed challenges to the interpretation of the injuries.

Apart from the injuries to the cranium, Burial 123 did not display any other obvious perimortem injuries. This young adult male was interred with a fragmentary prehispanic undergarment and a simple textile layer that are consistent with prehispanic textiles from the Central Coast of Peru during the Inca Empire. However, Burial 123 was recovered in a prone position and was not interred with any burial offerings, which is distinct from the Late Horizon mortuary patterns. Metal residues from the projectile were not detected by standard radiographic analysis and no projectile was recovered from the burial context.

Burial 248 (male, 18–20 years) displayed three quadrangular shaped defects to the left parietal and occipital that likely represented sharp-force trauma inflicted by a steel-edged weapon (Fig. 6). The sizes of the three defects averaged approximately 8 mm in the anterior-posterior dimension and 5.25 mm in the superior-inferior dimension. A small hinging fracture of the outer table of the cranium was found on the superior edge of one of the defects on the left parietal. Plastic deformation at the cruciform eminence of the occipital was observed on the interior of the defect, indicating that the weapon first pierced the exterior of the cranium, but it did not completely perforate the inner table (Fig. 6). The entire midface of Burial 248 was missing and there are two fractures that radiate from the supraciliary arches of the

Fig. 5. Left, interior view of projectile entrance with internal beveling. Right top, view of the compressed ectocranial surface of the plug of bone recovered among the facial fragments. Right bottom, view of the endocranial surface of the plug with four radiating fractures. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Fig. 6. Top, quadrangular defects to the left parietal and occipital of Burial 248. Note the hinging fracture on the more superior of the defects on the left parietal. All the defects were approximately 8.78 mm × 5.24 mm (average). Bottom left, close-up of quadrangular defect on occipital. Bottom right, interior of the quadrangular defect on the occipital viewed from the foramen magnum. Note how the cruciform eminence was not entirely perforated and how the bone is still attached to the endocranial wall. The defects are nearly the same size, suggesting that the same implement produced them. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

frontal, as well as perimortem damage to the left and right zygomatic arches and nasal bones. The mandible had a perimortem parasymphyseal fracture to the right of the mental symphysis with areas of irregular chipping and angular edges consistent with blows sustained at or around the time of death. The left and right mandibular

Fig. 7. Top, anterior oblique view of Burial 231 with the defect on the left frontal and extensive perimortem damage to the left craniofacial region. The defect measures approximately 10.84 × 23.02 mm. Bottom left, close up of oval defect. Bottom right, the plug was recovered while it was still attached to the interior of the superior edge of the defect. It was not compressed and it did not have any radiating fractures on its endocranial surface. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

first and second molars exhibited chipping and breakage on their buccal surfaces that are likely associated with the blows to the face, as there is no polishing or wear and the breakage does not appear to be postmortem.

Burial 248 also sustained multiple injuries to the postcranial skeleton, including perimortem fractures to the left first rib, the proximal tibia, and the left third and fourth metacarpals (Supporting Information, Figs. 2 and 3). The proximal end of the right tibia sustained a complete fracture to the upper third of the diaphysis, and the staining on the edges of the injury was inconsistent with recent breakage (Supporting Information, Fig. 2). There was evidence of perimortem breakage to the left third and fourth metacarpals in the form of peeling, irregular fracture margins, and splintering (Supporting Information, Fig. 3). The distal ends of the metacarpals and the accompanying phalanges are absent. Only these two fingers were missing and none of the other fingers possessed perimortem breakage, and all of the metacarpals and phalanges were recovered from the remaining fingers. Burial 248 was recovered intact in a semi-flexed position on its side with a textile strap wrapped around the body and was one of the atypical burials.

Fig. 8. Extensive perimortem damage to the left side of cranium of Burial 121. Three circular defects that were roughly the same size (black arrows) are also noted. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Several other individuals from 57AS03 displayed injuries that are anomalous and distinct from the perimortem injuries from either Huaquerones or 57AS03 (Figs. 7 and 8, Supporting Information, Fig. 4). One young adult female (Burial 231; 16–18 years of age) from an intact burial showed an ovoid defect on the left frontal, measuring 23.0 mm mediolateral dimension and 10.8 mm in the anterior-posterior dimension (Fig. 7). The anterior rim of the defect was compressed with a wrinkled appearance (Fig. 7). The plug from this injury was recovered from the anterior edge of the defect, hinging inside the cranium at the time of its discovery (Fig. 7). The defect exhibited internal beveling and the endocranial surface of the plug was larger than the ectocranial surface. However, no defects that might be characterized as projectile exit wounds were observed and no projectiles were recovered from the interior of the cranium. The cranium had additional perimortem injuries to the left frontal, left maxilla, and the left parasymphyseal region of the mandible and there was also a small ovoid defect on the occipital. Standard radiography did not detect any metal residues on the cranium.

Eight separate defects were observed on the left nasal, maxilla, frontal, parietal, and temporal of Burial 121, an adult male between the ages of 35 and 40 years. Three of the defects are ovoid or circular depression fractures, one was a small punctate defect to the left nasal, and the remaining defects were larger, irregular in shape, and possessed radiating fractures that have caused additional damage to other areas of the cranial vault (Fig. 8). The ovoid depressions ranged in size from 10.6 mm to 15.2 mm in their largest dimension. Burial 121 did not display any additional perimortem or antemortem injuries and the burial context was intact, but there were no burial offerings and the burial orientation and position were atypical.

DISCUSSION

For several reasons, we believe that some of the perimortem injuries from 57AS03 provide the first physical evidence of violent confrontations with the Spanish in the Andes. First, when compared with other studies of warfare and conflict-related trauma, the frequency of perimortem traumatic injuries is high in the sample from 57AS03 (25.8%). In comparative paleoepidemiology, rarely do frequencies of perimortem traumatic injuries reach such "double-digit" figures (Smith, 2003; Milner, 2005). Only in cases of ritualized violence, massacres, or battlefield cemeteries do frequencies of perimortem trauma usually exceed 25% (Willey and Emerson, 1993; Willey and Scott, 1996; Novak, 2000; Milner, 2005). Similarly, high frequencies of violent trauma were also reported from the Santa Barbara Channel Islands and northern Chile, but these are rare exceptions, the injuries were not lethal, and they did not include massive fracturing of the entire cranium (Walker, 1989; Torres-Rouff and Costa Junqueira, 2006). The nature and pattern of perimortem injuries between Huaquerones and 57AS03 indicate a different context of violence. The frequency of perimortem injuries observed in the Huaquerones sample is consistent with other studies of prehispanic warfare and violence in the Central Andes, as are the nature of the perimortem injuries, their size, and their location (Verano, 2003a,b, 2008; Andrushko, 2007; Tung, 2007; Klaus, 2008). Accordingly, we would argue that it is reasonable to suggest a degree of Spanish involvement in at least some, if not all of the traumatic injuries recorded, particularly among the atypical burials from 57AS03. The Incas mounted an uprising and laid siege to the Spanish capital at Lima (Ciudad de los Reyes) in A.D. 1536. The battle is said to have occurred near the center of Lima, located approximately 12 km from the archaeological zone of Puruchuco-Huaquerones, and ethnohistorical sources report that some of the retreating indigenous troops fled through the Rímac Valley on their way to the highland regions (Del Busto Duthurburu, 1978a; Vega, 1980). The individuals with perimortem injuries could represent individuals killed during the siege, who were then collected and buried hastily by their families. These individuals could also be victims of retributive violence on the part of the Spanish and their indigenous allies after the siege. Alternatively, they could also represent unfortunate victims in isolated encounters with the conquistadors, their allies, and/or other native communities within the postconquest context of high levels of violence and warfare, including native vs. native violence, a phenomenon that has been reported in other areas of the Americas (Stodder and Martin, 1992).

Second, several of the cases have characteristics that are comparable with injuries reported from other studies of medieval weaponry or with modern forensic investigations. We believe the circular injury to the left parietal of Burial 123, is consistent with published reports of entrance wounds in modern firearm trauma and with historical descriptions of low-velocity firearm injuries (Gross, 1861; Magee, 1995; Berryman and Symes, 1998; DiMaio, 1999; Longmore, 2006). The size and nature of the plug and circular defect are consistent with the 16th century projectiles known from Spanish Conquest in Peru and the circular defect possesses internal beveling. It is possible that the plug of bone was caused by the force of the projectile's entrance into the cranium and that the compressed area on the ectocranial surface of the plug may have been caused by the impact of the projectile. Some of the fractures and injuries to the anterior vault of Burial 123 are suggestive of damage caused by

the exit of a projectile, particularly if the projectile came apart, which has been reported in 19th century historical descriptions of round ball projectiles (Gross, 1861; p. 377-382; Magee, 1995; Longmore, 2006; p. 40). However, the fragmentary nature of these areas makes interpretation difficult and we cannot entirely rule out blunt force trauma causing the injuries to the left parietal and anterior cranial vault, as there is extensive damage and plugs and injuries with internally beveled edges have been reported from archaeological cases of blunt force trauma (e.g. Mays and Steele, 1996; Frayer, 1997; Paine et al., 2007).

The size and nature of the quadrangular defects on Burial 248 do not resemble injuries reported from prehispanic weapons from the Andes and it seems unlikely that indigenous maces, knives, or clubs caused these defects. Copper and bronze star-headed maces sometimes have rectangular points and can cause punched-out lesions and impact scars, but in cases from the Central Andes, they have not been observed penetrating the inner table of the cranium to the extent observed in this particular case (Verano, 2008). Penetrating injuries that are quadrangular in shape have been reported, but these are smaller in size than those on Burial 248 and they were not observed on cranial elements (Verano, 1986, 2008; p. 202). The positions of the quadrangular injuries, the absence of impact scars, and the absence of radiating fractures are more consistent with three separate perforating injuries, rather than blows from indigenous star-shaped maces. Notably, the quadrangular injuries on Burial 248 are similar to injuries on human remains from the medieval battlefield cemetery of Towton, England (A.D. 1461) (Novak, 2000). Novak (2000) argues that these injuries were likely caused by the top spike of a polearm or by the beak of a war hammer, which were among the types of weapons carried by the Spanish conquistadors (Salas, 1950; Del Busto Duthurburu, 1978a).

Burials 231, 121, and 107 represent cases of perimortem injuries that cannot be easily linked to a specific implement(s) and the dearth of information about the injuries caused by 16th century cross-bows, falconets, and "branched bullets" makes interpretation difficult. A blunt force implement may have caused the simple punched-out ovoid defect on the frontal of Burial 231, so Burial 231 could have received several blows from blunt force implements, like a stone mace. It appears unlikely that a firearm caused the ovoid defect because no exit wound present and no projectile was recovered. However, projectiles that lose their gyroscopic stability have been known to cause atypical and rectangular entrance wounds (e.g. Wiley and Scott, 1996). Multiple blows with a club or mace or projectiles fired from a falconet could have caused the numerous impact scars on Burial 121.

Although injuries from Spanish weapons appear to be present in the 57AS03 sample, the majority of perimortem injuries to the cranium were likely due to blunt force trauma, probably from native weaponry like maces or clubs, with only a few of the injuries caused by Spanish weaponry. What weapons caused these blunt force injuries is difficult to establish with any certainty, as it is extremely rare to be able to match an injury with a specific implement (Boylston, 2000; p. 259). The blunt force injuries could have been caused by European maces or clubs wielded by the Spanish or their native allies or they could have been caused by indigenous maces or clubs. It is widely known that the Spanish were allied with native warriors armed with traditional weapons (Del Busto Duthurburu, 1966; Hemming, 1970; Lockhart, 1972; Cieza de León, 1998; Restall, 2004). Some native communities, including those from the central coast, fought alongside the Spanish during the siege of Lima (Spalding, 1999; Rostworowski, 2002).

To date, we have not uncovered conclusive evidence of slashing injuries that might have resulted from swords or steel blades (although Burial 248 may have received piercing injuries from a steel-edged implement). Given the emphasis historians have placed on the superiority of steel, the Spanish skill with swords and the lethality of the sword in battle, this is unexpected, but may reflect historical biases emphasizing the importance of the sword. The fact that many of the conquistadors and their forces may not have been well equipped and may not have had access to swords may also explain the absence of injuries from swords (Lockhart, 1972; Restall, 2004). Also, soft-tissue injuries are elusive in the investigation of trauma from archaeological collections of human skeletal remains, and it is likely that the frequency of lethal injuries is much higher than that which has been observed and reported from this study (see also Walker, 2001; Milner, 2005).

Also, when the 57AS03 cemetery is compared with the nearby Huaquerones cemetery, some marked differences emerge. The nature and pattern of perimortem injuries between Huaquerones and 57AS03 indicate a different context of violence. The high prevalence of lethal perimortem injuries coupled with the atypical mortuary treatment in some of the burials from 57AS03 suggests that some of the individuals may have been interred hastily, perhaps in the highly charged and chaotic context following Spanish conquest. Also, there is a high frequency of multiple perimortem injuries and a high frequency of perimortem injuries to the thorax region in 57AS03, with injuries to the ribs, scapulae, and sternum. Other studies have reported that high frequencies of injuries to the cranium, ribs, and hands are evidence for interpersonal violence (Brickley, 2006; Brickley and Smith, 2006; Lovell, 2008). If these individuals with perimortem injuries to their postcranial skeletons lacked protective armor or wore only lightweight cotton padding, then this might explain the high numbers of injuries to the axial skeleton. Trampling by horses could also have contributed to the high number of perimortem injuries to the axial skeleton.

The higher number of males from 57AS03 affected by perimortem traumatic injuries and multiple injuries suggests that males were more often engaged in direct combat or that they were targeted by their attackers because they posed more of a potential threat. Moreover, the increased prevalence of male victims with multiple injuries perhaps suggests the intent to cause death. In contrast, the frequency of perimortem injuries observed in the Huaquerones sample is lower and appears consistent with other studies of prehispanic warfare and violence in the Central Andes, as are the nature of the perimortem injuries, their size, and their location (Verano, 2003a,b; Andrushko, 2007; Tung, 2007).

Ritualized violence, sacrifice, and mass burials are well known from the Central Andes and in these prehispanic instances, the frequencies of perimortem injuries are extremely high (Verano, 2001, 2007, 2008; Klaus, 2008; Standen et al., 2009; Klaus et al., in press). Bioarchaeologists have observed cutmarks, decapitation, mutilation, blunt force trauma, and perforating injuries from archaeological contexts that are evocative of ritual-

ized forms of violence, such as mass burials, sacrificial platforms, or reburial after death. In contrast, the frequencies of perimortem injuries from cemeteries and archaeological samples of human skeletal remains from the Central Andes are low and most of the injuries are the result of blunt force implements (Kellner, 2002; Altamirano et al., 2006; Torres-Rouff and Costa Junqueira, 2006; Tung, 2007; Andrushko, 2007). Unlike bioarchaeological studies from North America, few cases of scalping are known and no cases of embedded points or arrowheads are known (Bridges, 1996; Bridges et al., 2000; Jurmain et al., 2009). The high frequency of the perimortem injuries and the nature of the injuries, particularly among the atypical burials from 57AS03, suggest a heightened context of violence, such as one that would follow the arrival of the Spanish in the Andean region.

CONCLUSIONS

Scholarly understanding of violent Spanish confrontation with indigenous peoples in the Central Andes is derived exclusively from early colonial written sources. Although they provide an extraordinary amount of detail, these historical accounts must be read critically and cautiously because of the biases and agendas of their Spanish and indigenous authors, because of the tumultuous period during which they were recorded and written, and because they are limited in temporal and geographical scope (Silverblatt, 1987; Julien, 1993; Abercrombie, 1998; D'Altroy, 2002; and discussions therein). The view of Spanish colonization exclusively through this historical prism has been oversimplified and material evidence can complement and redress some of the lacunae in the collective knowledge about Spanish colonization in the Americas. However, the interpretation of the bioarchaeological record is not without its challenges. Here we argue that some of the individuals from Puruchuco-Huaquerones possess possible evidence of injuries from 16th century Spanish weapons, including possibly firearms and steel-edged weapons. However, the individuals with these perimortem injuries were not interred in a battlefield cemetery or as a single burial event. It appears that increased levels of violence—native vs. Spanish and native vs. native—contributed to the pattern and lethality of injuries we have observed. Although our data may challenge some of the a priori assumptions about how Spanish conquest occurred, we believe that our data offer an additional source of information about the violence following the colonial enterprise in the Central Andes. While the Spanish brought particularly lethal and devastating forms of violence, aggression, and repression, the social rupture and chaos that ensued may have also led to increased levels of violence between native communities. Historical emphasis on the sword as the Spanish weapon of choice may say more about the social and cultural contexts of the written accounts and their emphases, rather than practical realities of the conquistadors and their forces. Furthermore, during the first few years of Spanish conquest, the small numbers of Spaniards were heavily supplemented with native troops armed with native weapons because European weapons and ammunition were scarce. Therefore, the bioarchaeological signatures of these violent entanglements should evince a mix of injuries, rather than an overwhelming number of injuries from European weapons.

Bioarchaeological evidence of violence associated with Spanish conquest in the Americas has proven elusive despite long-term research into the biocultural impact of conquest, invasion, and colonialism. Some of the cases from Puruchuco-Huaquerones appear to represent the first evidence from the Central Andes of violent encounters after the conquest and invasion of the Spanish. The high frequency of perimortem injuries from 57AS03 is consistent with violent encounters, particularly given the high numbers of perimortem injuries to the cranium and axial skeleton. Some of the perimortem injuries from 57AS03 may represent the first material evidence of injuries sustained by European weaponry during the 16th century (circa 1532–1540). A high frequency of lethal, perimortem injuries was also observed in subadults from 57AS03 (Gaither et al., 2007), so the adults were not the only victims of heightened violence after Spanish Conquest. The high frequency of lethal perimortem injures in 57AS03 coupled with the atypical mortuary pattern suggests a reconfiguration of traditional mortuary rites amidst the chaos of Spanish conquest and invasion (Murphy et al., in press). In contrast, the nature and pattern of perimortem injuries from Huaquerones likely represent lethal interpersonal violence or warfare, but more likely waged between other communities from the region during the Late Horizon (A.D. 1470–1532) or between members within the community.

Puruchuco-Huaquerones is one of a handful of archaeological sites from the Americas with evidence of violent conflict with the Spanish, and historical archaeology of contact era sites in the Central Andes is in its nascent phases (Klaus, 2008; Wernke, in press; Quilter, in press). As the number of regional studies increases, it is likely that future work can present new evidence of the violence associated with Spanish Conquest and either bolster or challenge written historical accounts. The injurious effects of 16th century weapons and firearms, particularly with unusual and atypical types of projectiles, promises to be a fruitful area of future research for those interested in correlating injuries to the skeleton with causative implements, perhaps modeled after similar studies in forensic anthropology (e.g., Symes, 1992; Humphrey and Hutchinson, 2001; Tucker et al., 2001; Symes et al., 2002).

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