The embodiment of craft production in Bronze Age Portugal: Exceptional dental wear grooves in an individual from Monte do Vale do Ouro 2 (Ferreira do Alentejo, Portugal)

Running Title: Dental wear and embodied craft production in Bronze Age Portugal

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Abstract: Two human lateral mandibular incisors exhibiting exceptional dental wear in the form of lingual surface grooves along the cementoenamel junction were recovered from the superficial levels of a pit grave attributed to the Bronze Age at the archaeological site of Monte do Vale do Ouro 2 (Ferreira do Alentejo, Beja, Portugal). Although a number of analyses of dental wear features acknowledge the relatively common use of the dentition for non-dietary purposes (using the "teeth as tools") during the Early/Middle Bronze Age (2200–1200 BC) of southwest Iberia, the form of dental wear documented at Monte do Vale do Ouro 2 is not only a novel finding in this region, but has seldom been described in any bioarchaeological context. The present study provides a macroscopic and low-magnification description of the atypical dental wear for this individual. Results indicate that the incisors are likely antimeres. In addition to the deep lingual grooves, asymmetrical wear removed a substantial portion of the laterolingual crown volume of each tooth. Occlusal and lingual surface wear accumulated slowly enough for tertiary dentin to form. An occlusal groove is also present on the right I_2. A review of ethnohistoric and bioarchaeological literature suggests that some form of craft production involving the manipulation of cordage or fiber with the mouth and teeth can account for the unique wear patterns from Monte do Vale do Ouro 2. The hand-spinning of flax requires wetting which can

be accomplished by passing flax fibers through the mouth in a mediolateral direction while using a hand spindle. Similar habitual behaviors were probably practiced by the Bronze Age individual from Monte do Vale do Ouro 2. The wear grooves represent the embodiment of aspects of craft production and maintenance activities that occurred during this individual's lifecourse.

Keywords: pit grave, non-masticatory wear, Iberian Peninsula, Bronze Age, maintenance activities, embodiment, craft production, non-occlusal groove, Dental Anthropology

Introduction

The recent proliferation of excavations in southwest Iberia in general, and southern Portugal in particular, has greatly informed our knowledge of the Chalcolithic (3300–2200 BC) and Early/Middle Bronze Age (2200–1200 BC) archaeological contexts in the region—especially concerning the heterogeneity of funeral practices during this period (Alves et al., 2010; Filipe, Godinho, Granja, Ribeiro, & Valera, 2013; Pereira, Silva, Valera, & Profírio, 2017; Valério et al., 2014). Unfortunately, poor preservation of human remains has severely limited bioarchaeological reconstructions of human lifeways in southwest Iberia (Silva, Gil, Soares, & da Silva, 2017). However, among the few bioarchaeological studies from the Bronze Age of southern Portugal (Fidalgo & Silva, 2020; Fidalgo, Silva, & Porfírio, 2020; Fidalgo, Porfírio, & Silva, 2016; Pereira, Silva, Valera, et al., 2017a; Pereira, Silva, & Valera, 2017b; Silva, Gil, Soares, & da Silva, 2016; Silva et al., 2017, 2018), patterns of dental wear related to the non-masticatory use of the dentition for manipulative tasks have provided some of the most informative reconstructions of Bronze Age human habitual behaviors for the region (Fidalgo et al., 2020; Pereira et al., 2017a, b; Silva et al., 2016).

The analysis of dental wear—in the form of macrowear, microwear, and/or specific dental wear features (e.g., enamel chipping, notches, occlusal or interproximal grooves, notches, erosion, lingual surface attrition of the maxillary anterior teeth [LSAMAT], instrumental striations on labial/buccal surfaces, etc.)—provides data of biocultural relevance for the reconstruction and understanding of dietary variation, non-dietary manipulative behaviors, trauma, pathological conditions, cultural modification of the dentition for social expression of identities, occupation, and other indicators of past human lifeways (Alt & Pichler, 1998; d'Incau, Couture, & Maureille, 2012; Krueger, 2015; Krueger, Willman, Matthews, Hublin, & Pérez-Pérez, 2019; Milner & Larsen, 1991; S. Molnar, 1972; Schmidt, El Zaatari, & Van Sessen, 2020; Schmidt et al., 2019). The analysis of specific, idiosyncratic, or aberrant dental wear features are particularly illustrative for reconstructions of behavior and identity (Alt & Pichler, 1998; Crane, Watson, & Haas, 2020; Milner & Larsen, 1991; S. Molnar, 1972; Stojanowski, Johnson, Paul, & Carver, 2016; Willman, Hernando, Matu, & Crevecoeur, 2020), since these wear patterns can be coupled with inferences gained from ethnographically, ethnohistorically, and clinically documented patterns of atypical tooth-using tasks and the sociocultural contexts they involve (Barrett, 1977; Berbesque et al., 2012; Crowfoot, 1931; Daly, Bakar, Husein, Ismail, & Amaechi, 2010; Erdal, 2008; Fidalgo et al., 2020; Gould, 1968; Krueger, 2015; Merbs, 1983; Scott & Jolie, 2008; Vogeikoff-Brogan & Smith, 2010; Wheat, 1967).

Insights into the non-dietary, or non-masticatory, use of the anterior dentition for manipulative behaviors (use of "teeth as tools") are increasingly well-documented in the later prehistory of the Western Mediterranean and Iberia through the analysis of dental wear features (Carrasco, Bonilla, Mateo, & Sanjuán, 2017; Fidalgo et al., 2020; Lozano, Bermúdez de Castro, Arsuaga, & Carbonell, 2017; Lozano, Jiménez-Brobeil, Willman, et al., 2020; Marado et al.,

2017; Pereira et al., 2017a, b; Silva et al., 2016; Sperduti et al., 2018; Tanga, Quintili, Tinarelli, D'Anastasio, & Viciano, 2016; Willman, Lozano, Hernando, & Vergès, 2020). In this context, we contribute an analysis of two incisors from a Bronze Age context at the site of Monte do Vale do Ouro 2 that exhibit an exceptional case of dental wear grooves on their lingual surfaces (Pereira et al. 2017a, b). Dental wear grooves have been reported in several food-producing contexts from the later prehistory of the Iberian Peninsula (Fidalgo et al., 2020; Lozano et al., 2017, 2020; Pereira et al., 2017a, b; Silva et al., 2016), and typically correspond to a limited number of behaviors interpretable through analogy (see below). Dental wear features are an embodiment of the manipulative tasks and behaviors that produced them. As such, they can provide evidence for the social differentiation, intensification, or specialization in aspects of craft production or maintenance activities by age, sex, status, or other aspects of social identity when sufficient context is available. The present work contextualizes the biocultural significance of the dental wear features at Monte do Vale do Ouro 2 as a reflection of broader patterns of human lifeways of Bronze Age peoples of southwest Iberia.

Dental wear grooves and the embodiment of manipulative behaviors

Dental wear grooves can occur on the occlusal, interproximal, and lingual surfaces of the dentition. The etiologies of wear grooves relate to the surface they appear on, as well as their orientation and morphology (e.g., width, length, depth, and cross-sectional shape). The co-occurrence of grooves with other dental wear features or pathological conditions of the oral cavity are also informative for behavioral reconstructions.

The etiology, temporospatial distribution, and materials/behaviors involved in the formation of interproximal grooves have a long history of study (Bouchneb & Maureille, 2004; Brown & Molnar, 1990; Estalrrich, Alarcón, & Rosas, 2017; Formicola, 1988; Hlusko, 2003; Lukacs & Pastor, 1988; Ravy, Clère, & Puech, 1996; Ungar, Grine, Teaford, & Pérez-Pérez, 2001; Willman et al., 2019). Generally, interproximal grooves are found at or near the cementoenamel junction of postcanine teeth, although some cases are known for the anterior teeth (Estalrrich et al., 2017; Lozano et al., 2020; Schulz, 1977; Willman et al., 2019). The working of pliant cordage, sinews, fibers of plant or animal products, and similar materials in the interproximal spaces between adjacent teeth has been proposed as one mode of interproximal groove formation in certain cases (Brown & Molnar, 1990; Lozano et al., 2020; Lukacs & Pastor, 1988; Schulz, 1977). However, the majority of interproximal grooves identified in the literature correspond to the use of rigid or semi-rigid probes for "tooth-picking" behaviors—whether therapeutic or palliative in nature (Bouchneb & Maureille, 2004; Estalrrich et al., 2017; Formicola, 1988; Hlusko, 2003; Ungar et al., 2001; Willman et al., 2019).

Occlusal grooves are well-defined furrows on the occlusal surfaces of teeth, often with a rounded, semi-circular cross-section of variable depth and width. They are interpreted as forming through the abrasion of dental surfaces with materials like sinew, fibers, basketry materials, and cordage that are pulled across a tooth surface or otherwise worked with the teeth (Cybulski, 1974; Erdal, 2008; Fidalgo et al., 2020; Larsen, 1985; Lorkiewicz, 2011; Lozano et al., 2020; Minozzi, Manzi, Ricci, di Lernia, & Borgognini Tarli, 2003; Molleson, 2016; Pedersen & Jakobsen, 1989; Schulz, 1977; Scott & Jolie, 2008; Waters-Rist, Bazaliiskii, Weber, Goriunova, & Katzenberg, 2010). Abrasion from the movement of materials across tooth surfaces may produce characteristic microstriations within the boundaries of grooves with well-preserved surfaces (Larsen, 1985; Minozzi et al., 2003; Waters-Rist et al., 2010). The shape or "sharpness" of groove edges may also indicate the types of materials and task-behaviors performed

(Molleson, 2016). Grooves may be isolated, continuous across adjacent teeth, or appear matched/symmetric with grooves on teeth that are not immediately adjacent (Erdal, 2008; Larsen, 1985; Lorkiewicz, 2011; Schulz, 1977). The term "cultural notches" used by Cruwys and colleagues (1992) is synonymous with our use of "occlusal groove" here.

Habitual or occupational notches are wear features resembling "indentations" on the occlusal surfaces of teeth, and are generally attributed to behaviors that involve biting down on, clenching, or holding objects between opposing teeth (Bonfiglioli, Mariotti, Facchini, Belcastro, & Condemi, 2004; Cruwys et al., 1992; Scott & Jolie, 2008; Tanga et al., 2016). Habitually holding hard items such as pipe stems, carpenter's nails, and sewing needles; "cutting" thread with the anterior teeth; and cracking seeds (e.g., pumpkin, sunflower, melon) are common causes of notches in ethnohistoric and contemporary clinical settings (Alt & Pichler, 1998; Cruwys et al., 1992; Kaidonis, Ranjitkar, Lekkas, & Townsend, 2012; Prpić-Mehičić, Buntak-Kobler, Jukić, & Katunarić, 1998; Turner & Anderson, 2003).

Grooves on the lingual surfaces of anterior teeth have been attributed to the manipulation of pliant cordage, yarn, and thread made of plant or animal materials (Erdal, 2008; Lozano et al., 2020; Pereira et al., 2017). Lingual grooves are relatively rare in bioarchaeological contexts which may relate to the more specialized task behavior(s) that create them—like hand spinning and mouth wetting fibers in specific contexts (Erdal, 2008). However, occlusal grooves with "sharp edges" have also been attributed to spinning tasks (Molleson, 2016), and highlights the difficulties in associating one type of groove to a specific type of behavior or worked material.

Lingual grooves, occlusal grooves, and interproximal grooves (especially anterior ones) may co-occur in the same or multiple individuals from particular archaeological sites which suggests that they result from a similar task or set of tasks for this class of wear features (Erdal, 2008; Lorkiewicz, 2011; Lozano et al., 2020; Schulz, 1977). Thus, dental wear grooves are wear features of interest for broader discussions of craftwork, since these wear features often represent the embodiment of specific steps in the process—or chaîne opératoire—for producing textiles, basketry, fibrous goods, and cordage among many other forms of organic material culture that only preserve in exceptional archaeological contexts. Grooves—in addition to other dental wear features—can offer additional insights into the social dimensions of craft production since they often co-vary with aspects of sex, gender, status, or occupation-based divisions of labor (Berbesque et al., 2012; Erdal, 2008; Estalrrich & Rosas, 2015; Larsen, 1985; Lozano et al., 2020; P. Molnar, 2008; Scott & Jolie, 2008; Watson & Haas, 2017).

The archaeological context

The site of Monte do Vale do Ouro 2, located in Ferreira do Alentejo (Beja), in the southwest of Portugal (**Figure 1**), was discovered in 2013 during a salvage archaeology project completed by a private archaeological company (ERA Arqueologia SA) (Moro Berraquero & Figueiredo, 2013). Two mortuary contexts were recovered among the 112 identified archaeological features. The mortuary contexts consisted of two pits, one dated to the Chalcolithic (Pit 97) and the other to the Bronze Age (Pit 102) (see Pereira, et al., 2017a, b for additional archaeological context). The latter is of concern in the present analysis.

Pit 102, measuring 1.22 m in diameter and 1.16 m in depth, was recovered in the northeast sector of the site and contained three distinct phases of inhumation (Moro Berraquero & Figueiredo, 2013). Each phase contained a primary burial numbered from the oldest to the most recent deposition (skeletons 10207, 10205, and 10202) (Moro Berraquero & Figueiredo, 2013). The most superficial level (10200) also contained diaphyseal fragments of a femur and

ulna, a largely unworn mandibular premolar, and two lateral mandibular incisors (left and right I_2s). The three inhumations and fragmentary remains suggest a minimum number of four individuals from Pit 102.

The three in situ burials were uncovered in lateral decubitus with flexed limbs (Pereira, et al., 2017a, b). Individual 10207 was placed on the left side, whereas individuals 10205 and 10202 were placed on their right sides. Individual 10207 is considered a female based on sexually dimorphic features of the cranium and the vertical diameter of the femoral head (39 mm) (Pereira, et al., 2017a, b). The open apex of his lower right third molar, fused iliac crest, and the unfused sternal epiphysis of the clavicle suggest an age at death around 22 years old (AlQahtani, Hector, & Liversidge, 2010; Scheuer & Black, 2000). The gracile aspect of bones belonging to individual 10205 suggests a female skeleton, and antemortem tooth loss and the reduced thickness of cortical bone suggest an older individual (Pereira, et al., 2017a, b). Age estimation for the non-adult individual 10202, is 5–7 years old according to dental eruption (Smith, 1991). A similar age at death (6.5–7.5 years) is obtained following AlQahtani and colleagues (2010).

The incisors recovered from the superficial stratigraphic unit (10200) of the Pit 102, were previously considered I^1s (Pereira et al., 2017a, b), but are revised as I_2s here. The I_2s do not belong to the non-adult individual (10202) but could belong to the probable female older adult (10205). The incisors display unequivocal evidence for the non-masticatory use of the teeth for manipulative behaviors (Pereira et al., 2017a, b). The wear features consist of a profound groove that excised a substantial amount of root tissue at the level of the cementoenamel junction on the lingual aspect of each tooth. The similarity in occlusal and non-occlusal gross wear, overall condition of the teeth, and co-occurrence in the superficial level of the pit suggests the incisors are antimeres. While dental wear features documented in other Bronze Age contexts from Portugal suggest that the use of teeth for non-dietary behaviors was relatively common (Fidalgo et al., 2020; Silva et al., 2016), the non-occlusal grooves on the incisors from Monte do Vale do Ouro 2 are rarely documented in the bioarchaeological literature (e.g., Erdal, 2008; Lozano et al., 2020). Thus, this exceptional case of non-dietary dental wear from the Bronze Age of southwest Iberia warrants further analysis and contextualization given the rarity of similar cases in both a regional and global perspective.

Methods

Gross features of the teeth were documented through direct observation, macrophotography, and close-range photogrammetry. 3D photogrammetry models were created using Meshroom (AliceVision, version 2020.1.1). A digital optical light microscope (Dino-Lite AM73915MZTL) was used to assess finer details of wear and preservation. Software (DinoCapture 2.0 Version 1.5.30B) associated with the microscope was used for direct measurements of dental wear features (see **Supplemental Figures 1** and **2**). Given the atypical pattern of wear, a description rather than use of standardized scoring procedures was undertaken.

Results

Both teeth exhibit some postmortem exfoliation of enamel, dentine, and root tissue, but most of each tooth surface is well-preserved enough to make macroscopic observations of wear. Following Smith (1984), the occlusal surface wear is a stage of 3 or 4, but this is only an approximation since the lingual surface exhibits heavy and asymmetric wear. There is no

antemortem dental chipping of grade 1 or larger (following Bonfiglioli et al., 2004), although there are numerous, small postmortem enamel fractures on both incisors.

Both the left and right I_2 exhibit an exceptional, atypical pattern of dental wear. A deep groove is worn into the lingual surface of the root, just below the cementoenamel junction, on both teeth (**Figures 2** and **3**). In addition, a considerable amount of the laterolingual portion of each crown (enamel and dentin) is worn away antemortem (**Figures 2** and **3**). Secondary and tertiary dentine is exposed on most of the lateral half of the lingual surface of the left I_2, and a similar, albeit less extensive, loss of tissue is mirrored on the right I_2. The angle of each lingual groove runs from the mesiolingual aspect to the laterolabial edge of the cementoenamel junction, which makes the length of the groove longer on the mesial side than the lateral side. However, the groove on the right side is much longer in its labiolingual length (mesial ≈5.2 mm, lateral ≈3.5 mm) compared to the left side (mesial aspect ≈2.6 mm, lateral aspect ≈2.1 mm) (**Supplemental Figures 1** and **2**). Despite differences in length, the apicocervical height of each groove are similar (right I_2 ≈1.1 mm; left I_2 ≈1.1 mm) when measured from either mesial or lateral view (**Supplemental Figures 1** and **2**). The left I_2 exhibits considerable postmortem damage immediately apical to the lingual root surface groove (medial and lateral views of **Figure 2** and **3**). There is no exposure of the pulp chamber which suggests that crown and lingual root wear progressed slowly enough for the deposition of tertiary dentine to prevent pulp exposure.

The right I_2 also exhibits a shallow occlusal groove that runs in the same mesiolingual to laterolabial orientation of the lingual groove near at the cementoenamel junction (**Figure 4**). The softer dentine is preferentially worn away and the border of the groove is formed by the remaining enamel.

3D photogrammetry models of each incisor are located in the Supplemental Information (**Supplemental Figures 3** and **4**) to better assess gross details of the dental wear.

Discussion

Determining the exact behavior(s) influencing the formation of the grooves in the present case is difficult, and several scenarios are possible. One possibility is that the lingual grooves on both incisors were worn simultaneously by cordage or fiber being passed through them—implying that the I_1s (missing postmortem) also exhibited similar lingual root grooves (**Figure 5A**). Another scenario is that each tooth was used for similar purposes, but not simultaneously, perhaps switching the side cordage was worked on as a result of an initial deep groove forming (**Figure 5B)**. This latter scenario could account for some of the asymmetry in wear patterns; however, other factors—like handedness and occlusal variation (e.g., incisor rotation and/or crowding)—could also account for the different degree of wear on the right and left I_2s and the subtle variation in groove size and orientation. The extensive wear to the laterolingual portion of the crown is a probable consequence of the corded material entering and exiting the mouth over the occlusal surface to reach the lingual root grooves. More certainty can be attributed to the habitual engagement in the behavior(s) that contributed to the wear on the incisors from Monte do Vale do Ouro 2. The presence of secondary dentin and a lack of pulp chamber exposure suggests that this individual engaged in these behaviors that induced a pace of wear that did not cause *pulpitis* or traumatic loss. The uniformity of the lingual groove height and symmetry of the lingual surface wear also suggests that the material(s) abrading the I_2s were relatively uniform during the portion of the lifecourse in which this individual engaged in the activity or activities that produced them.

Occlusal and non-occlusal grooves on the anterior dentition in bioarchaeological assemblages are often interpreted as evidence for the habitual manipulation of various forms of cordage, sinew, thread, yarn, and other fibrous materials of plant or animal origin (Bocquentin, Sellier, & Murail, 2005; Cybulski, 1974; Erdal, 2008; Frayer, 2004; Frayer & Minozzi, 2003; Larsen, 1985; Lorkiewicz, 2011; Minozzi et al., 2003; Molleson, 2016; Pedersen & Jakobsen, 1989; Ravy et al., 1996; Schulz, 1977; Scott & Jolie, 2008; Sperduti et al., 2018; Vogeikoff-Brogan & Smith, 2010; Waters-Rist et al., 2010). Such interpretations generally rely on the numerous ethnohistoric and clinical examples that detail the non-masticatory uses of the dentition for weaving, cutting, wetting, plucking, and hand spinning of fiber and cordage (Crowfoot, 1931; Cybulski, 1974; Erdal, 2008; Fidalgo et al., 2020; Larsen, 1985; Powers, 1875; Prpić-Mehičić et al., 1998; Schulz, 1977; Scott & Jolie, 2008; Vogeikoff-Brogan & Smith, 2010; Wheat, 1967). This class of tooth-using activities contributing to atypical patterns of dental wear, like grooves, can often be ascribed to *maintenance activities*—the activities of everyday life—which are discussed further below (Aranda et al., 2009; Montón-Subías, 2014). The several archaeological and ethnographic examples that follow contextualize the probable relationship between atypical dental wear features and maintenance activities for the individual from Monte do Vale do Ouro 2.

Using ethnographic and bioarchaeological analogies, Erdal (2008) hypothesized that the mesiolaterally-oriented occlusal and lingual surface grooves in female individuals from a 10th century bioarchaeological context in northern Anatolia were formed from wetting yarn that was passed through the mouth and across anterior tooth surfaces. Indeed, one of the individuals from the study (Erdal, 2008) exhibits marked occlusal wear coupled with the form of lingual surface grooving exhibited in both the Monte do Vale do Ouro 2 incisors. Interestingly, neither I_2 in the present study exhibits the same extreme occlusal wear of the Anatolian individual. Instead, the right I_2 from Monte do Vale do Ouro 2 also exhibits an occlusal groove in addition to the non-occlusal groove. Thus, non-occlusal grooves do not have to occur as a result of a loss of occlusal surface through attrition, but rather, they can co-occur—perhaps corresponding to different aspects or stages of fiber processing, or changing functionality of the tooth surfaces as atypical wear progresses during the lifecourse. Nevertheless, Erdal (2008) provides a compelling case for how the wetting yarn could contribute to occlusal and non-occlusal groove formation—especially those grooves oriented mesiolaterally on the anterior dentition since they mirror the orientation of fiber-processing by contemporary hand-spinners.

The asymmetric crown wear—disproportionately located in the laterolingual portion of the crown—on the Monte do Vale do Ouro 2 incisors is reminiscent of wear on the dentitions of some individuals of Coast Tsimshian ancestry from the area of Prince Rupert Harbor, British Columbia (Cybulski, 1974). Cybulski (1974) attributed the occlusal wear grooves from the Prince Rupert Harbor individuals to abrasion by fibers that were held, moistened, pulled, or otherwise manipulated with the mouth and teeth. The ethnohistoric analogies from Northwest Coast contexts suggest that the dental wear grooves relate to non-masticatory behaviors that assisted in the manufacture of woven baskets and/or blankets by highly skilled individuals (Cybulski, 1974). Cybulski (1974:33) also noted that: "Once the grooves were initially formed, they would continue to provide an effective 'tool' for maintaining uniformity of the fine fibrous strands." The repetitive behaviors that contributed to the formation of the occlusal, lingual, and particularly the non-occlusal grooves near the cementoenamel junction of the Monte do Vale do Ouro 2 incisors, also suggests uniformity in the size of the fibers that were guided through the grooves. Furthermore, wear progressed slowly enough that tertiary dentine formed and prevented

the exposure of the pulp chamber. Thus, the form of the grooves indicates uniformity in the behaviors that produced them over a considerable amount of the individual's lifecourse, and further indicates a certain effectiveness of the grooves as an embodied "tool" for craftwork and/or maintenance activities (see below).

Dental wear features (grooves, chipping, heavy labial or lingual wear, etc.) were recorded among 6 of the 11 individuals with preserved teeth from the Middle Bronze Age necropolis of Casas Velhas (Melides, Portugal) and provide evidence of both dietary and non-dietary uses of the dentition (Silva et al., 2016). Especially relevant is an individual of unknown sex that exhibits a mesiolaterally-oriented lingual groove and heavy wear on the right I^1 in addition to loss of enamel on the left I_1 which is possibly related to working vegetable fibers (Silva et al., 2016). Similarly, among 21 individuals (11 female, 9 male, and 1 unknown sex) from the Middle Bronze Age rock-cut tombs of Torre Velha 3 (Serpa, Portugal) examined for atypical dental wear (i.e., LSAMAT, chipping, anterior occlusal grooves, and oblique wear planes), 5 cases (4 female and 1 unknown sex) were documented (Fidalgo et al., 2020). Atypical wear among the Torre Velha 3 females was also associated with greater rates of antemortem tooth loss (11.84%, n=76 teeth) than individuals with typical dental wear (1.06%, n=189 teeth), and all females with atypical wear features exhibit some antemortem tooth loss (Fidalgo et al., 2020). With reference to several ethnohistoric examples illustrating the use of the mouth and dentition in the process of wetting and hand-spinning flax fibers in Iberia (Oliveira, Galhano, & Pereira, 1978; Smith, 1951) and elsewhere (Crowfoot, 1931; Erdal, 2008), Fidalgo and colleagues (2020) suggest that the dental wear features and antemortem tooth loss at Torre Velha 3 and Casas Velhas can be partly attributed to similar types of non-masticatory behaviors. While dental wear features have not been directly observed among ethnohistorically documented flax spinners, the predominantly mesiolateral passage of fibers through the mouth and across the dentition is well-documented (Erdal, 2008; Fidalgo et al., 2020) and probably contributed to abrasive wear. Spinning flax requires wetting it, and it is not uncommon to wet spindle spun flax with the mouth (Alice Bernardo, personal communication). Behaviors related to the wetting and hand spinning of flax fiber were common enough to have earned a place in late 19th and early 20th century art and popular culture (**Figure 6**), and are still demonstrated by individuals possessing knowledge of traditional craft production, techniques, and skills (**Figures 7** and **8**).

Recent analyses of non-dietary wear features (chipping, notches, and occlusal and non-occlusal grooves) of individuals from the Argaric site of Castellón Alto (Middle Bronze Age to early Late Bronze Age, 1900–1600 BCE) in southeastern Iberia document atypical dental wear features in 5 individuals—all female—of 106 individuals observed from the site (Lozano et al., 2020). Notably, all five individuals display occlusal grooves and some have additional forms of non-occlusal grooves (Lozano et al., 2020)—one of which is quite similar to the grooves documented in the individual from Vale do Monte do Ouro 2. The patterning of wear features is suggestive of sex-based divisions of labor at Castellón Alto related to maintenance activities such as the manipulation of fiber, cordage, and related materials (Lozano et al., 2020).

The Bronze Age archaeological record of southern Iberia offers additional evidence for the range of materials that may have been worked with the anterior teeth at Monte do Vale do Ouro 2. For instance, offerings of meat are well-documented in Bronze Age funerary contexts in southern Portugal (Alves et al., 2010; Filipe et al., 2013; Silva et al., 2017; Valério et al., 2014), and in some cases are represented by wool-bearing (*Ovis*) animals (Fidalgo et al., 2016, 2020). However, plant materials—and especially flax—were probably the most common raw material for clothing production in the 3rd and 2nd millenium BP of southern Iberia (Costeira and

Mataloto, 2018), and a rare example of flax or hemp fibers and a metal awl are documented from a Bronze Age female burial at Bela Vista 5 in southern Portugal (Bottaini et al., 2014; Cunha et al., 2018; Valera and Simão, 2014). Awls were also recovered from many of the female burials of Torre Velho 3 (Fidalgo et al., 2016, 2020), a pattern that is mirrored in Argaric contexts in southeastern Iberia where awls are found exclusively in female and some child burials (Aranda, Montón-Subías, Sánchez-Romero, & Alarcón, 2009; Lozano et al., 2020; Montón-Subías, 2014). As reviewed in literature concerning Argaric contexts, awls are generally associated with maintenance activities centered around the production, maintenance, and repair of leather goods, basketry, textiles, and other (often perishable) material culture (Aranda et al., 2009; Jover Maestre & López Padilla, 2013; Lozano et al., 2020; Montón-Subías, 2014). While no objects associated with maintenance activities were recovered in the pit with the grooved incisors at Monte do Vale do Ouro 2, the teeth themselves can be viewed as the embodiment of such maintenance activities.

Conclusion

Recent excavations and analyses are providing a wealth of information on the Bronze Age archaeology of southern Iberia and southern Portugal in particular. Non-masticatory dental wear from Casas Velhas, Torre Velha 3, Castellón Alto, and Monte do Vale do Ouro 2 emphasizes the importance of the body—and specifically the anterior dentition—as both a bodily interface with, and reflection of, quotidian behaviors and maintenance activities. The mandibular lateral incisors of Monte do Vale do Ouro 2, with their profound grooves and asymmetric wear, provide evidence for working of cordage—probably related to the wetting and hand spinning of flax, wool, or similar fibers. This embodied behavior provides indirect evidence of the production of, or interaction with, perishable material culture that is otherwise only inferred from durable material culture (e.g., loom weights/loom elements, spindle whorls, awls, needles, etc.). Admittedly, sample sizes documenting non-dietary tooth-use from Bronze Age contexts in southwestern Iberia are small, but the presence of atypical dental wear features documenting embodied dimensions of craft production repeatedly occur despite poor skeletal preservation in the region. Thus, where bioarchaeological evidence is available, we can begin to integrate the paleobiological evidence of human lifeways into the operational sequence—or *chaîne opératoire*—for the production and maintenance of composite materials like textiles.

Supplemental Materials: The 3D photogrammetry models, texture file, and original images used for their creation are available open access in the Zenodo repository: http://doi.org/10.5281/zenodo.4293770.

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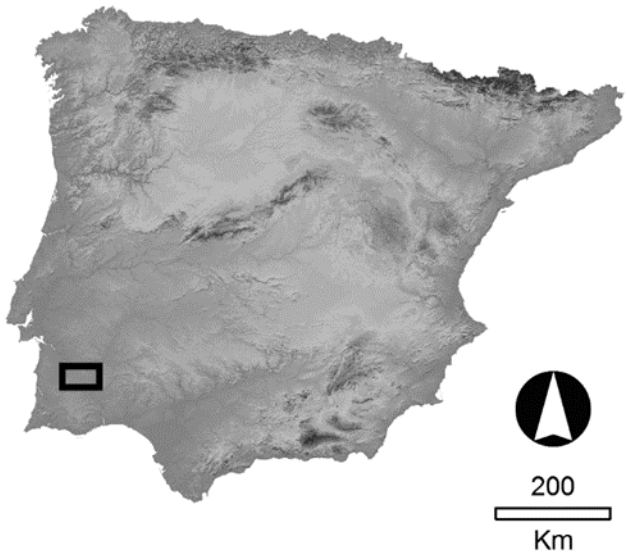


Figure 1. Location of the site of Monte do Vale do Ouro 2 in the Iberian Peninsula.

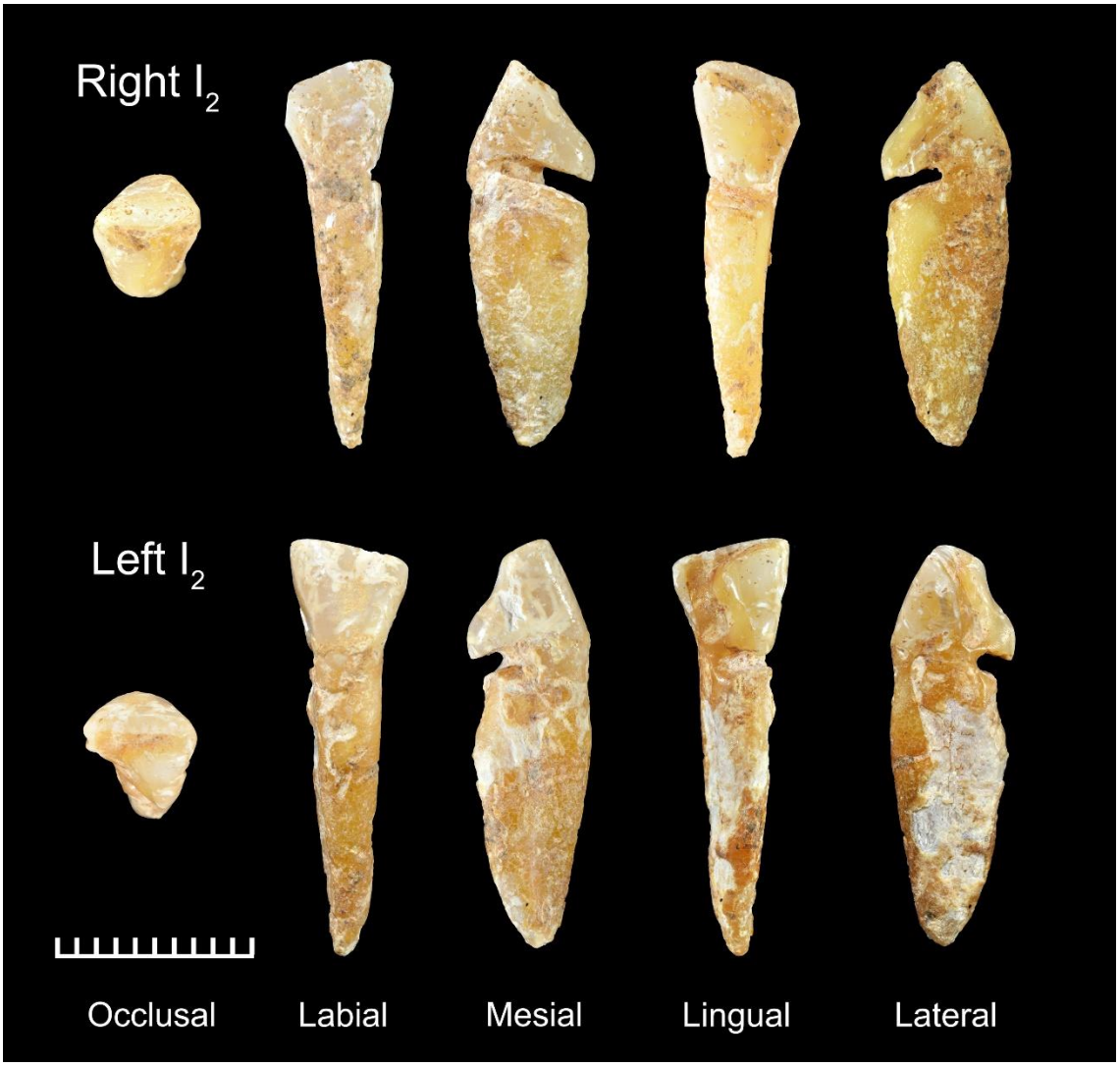


Figure 2. Monte do Vale do Ouro 2 mandibular lateral incisors in standard orientations. Large grooves are visible along lingual cementoenamel junction surface. Scale increments are 1 mm.

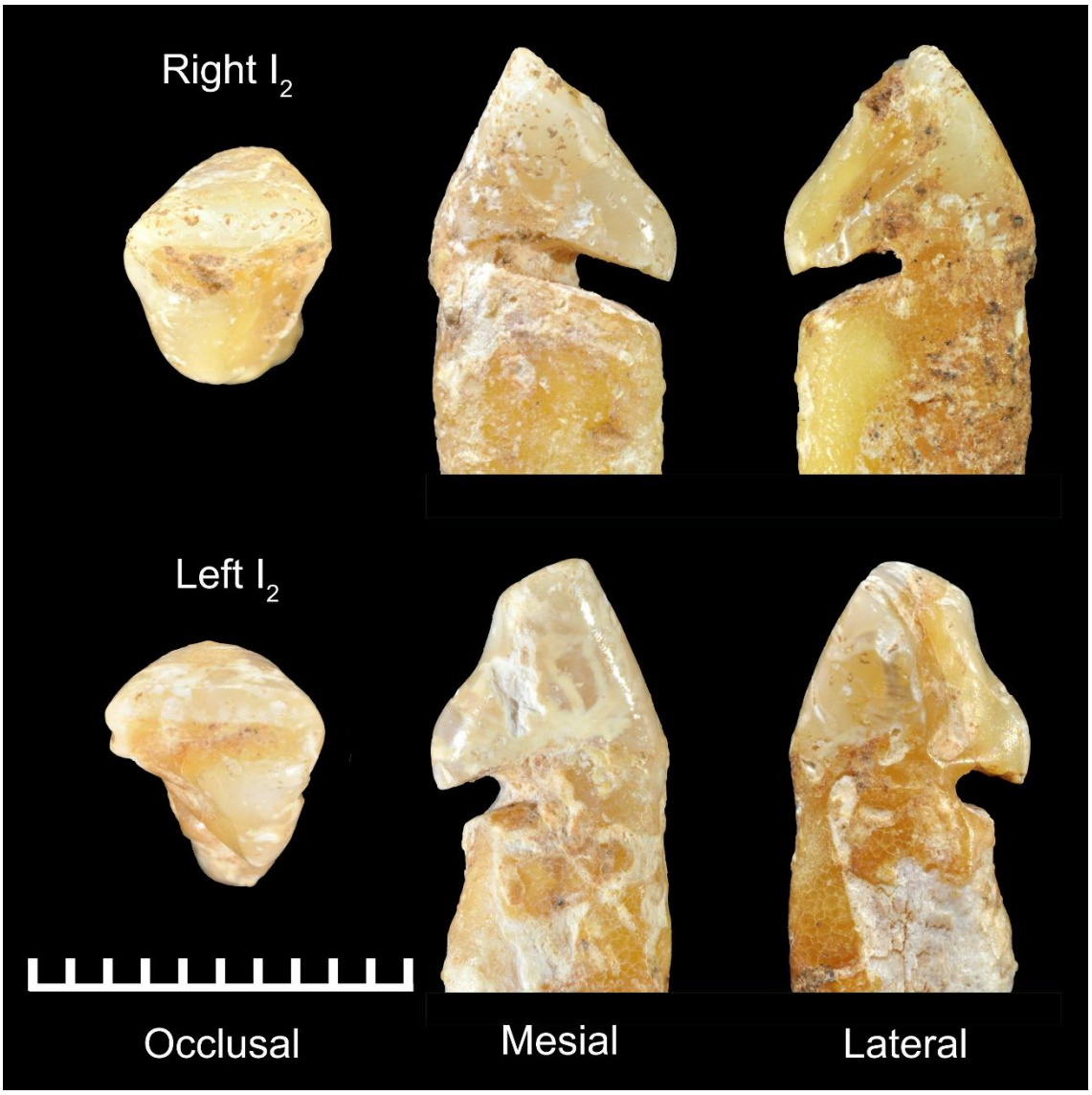


Figure 3. Closer view of Monte do Vale do Ouro 2 mandibular lateral incisors in standard orientations. Large grooves are visible along lingual cementoenamel junction surface. Note substantial antemortem loss of distolingual portion of crown due to wear. Scale increments are 1 mm.

Figure 4. Oblique view from lingual perspective of the Monte do Vale do Ouro 2 right mandibular lateral incisor emphasizing occlusal surface groove. Scale increments are 0.1 mm.

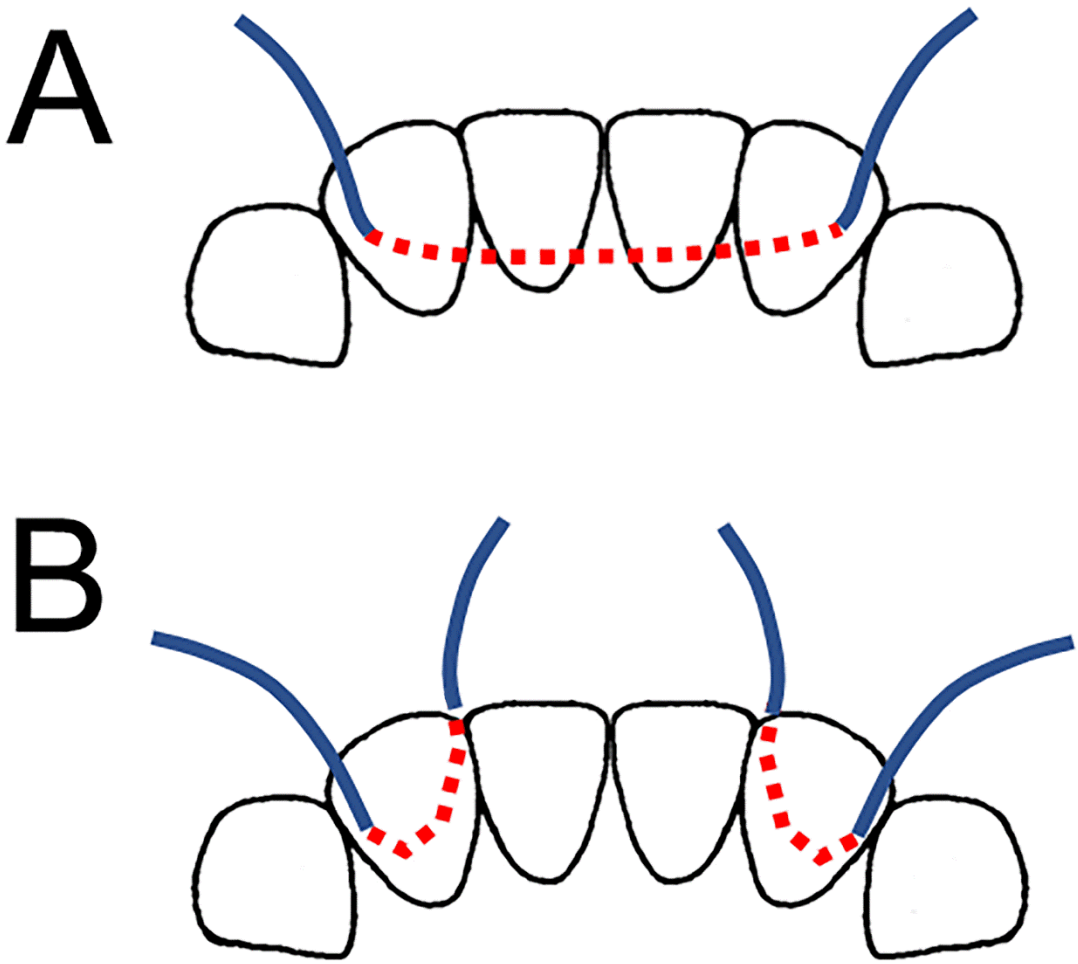
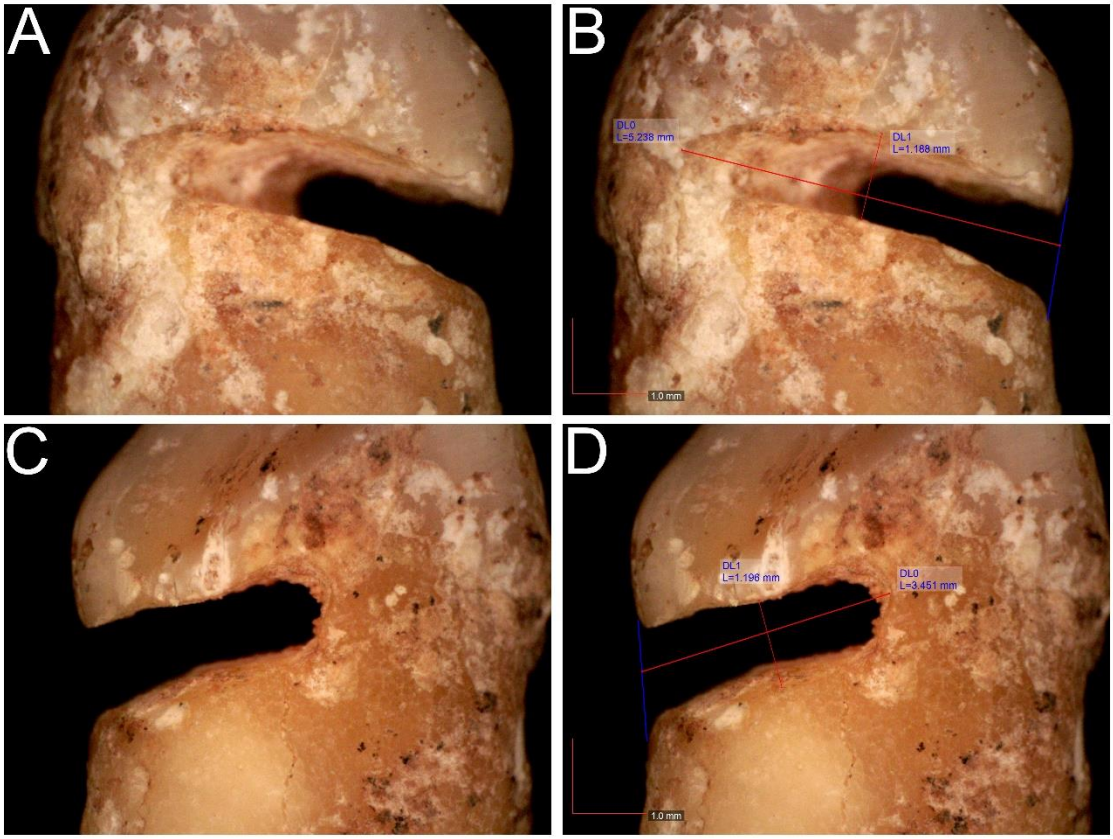


Figure 5. Occlusal view of two schematic interpretations of possible scenarios for the formation of the lingual surface wear and root grooves on the Monte do Vale do Ouro 2 incisors. Both scenarios assume 'standard' occlusal variations (e.g., no rotation, winging, or crowding). Postmortem missing teeth (right and left central incisors and canines) are shown for clarity but it is not certain whether they were missing antemortem. Thick solid lines indicate cordage visible in occlusal view, and dotted lines indicate approximate route of cordage through grooves not visible in occlusal view. A) Cordage enters mouth from right or left side over the lateral occlusal surface of the corresponding I_2. Cordage passes over laterolingual portion of crown and passes into the lingual root surface groove. Cordage exists mouth from opposite side it enters. B) Cordage worked in similar fashion to 'Scenario A' but only wrapping around one tooth at a time. Only one cord would be worked through one groove at any given time.

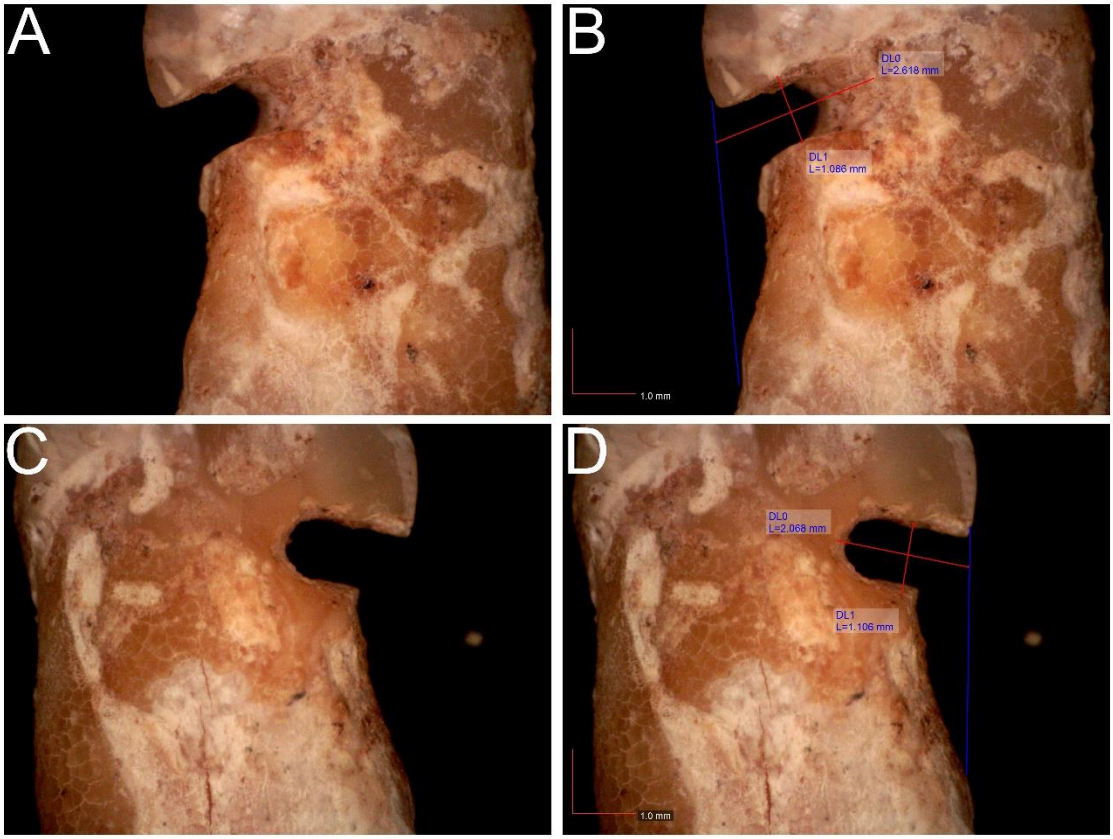
Figure 6. Examples of flax wetting and hand spinning depicted in popular culture. Top left: *Bien lo hilan* ("They spin well" [1807-1845]) by Leonardo Alenza y Nieto (https://www.metmuseum.org/art/collection/search/334953, CC0 1.0). Top right: *Velha Fiando* ("Old Spinner" [1904]) by José Malhoa (https://commons.wikimedia.org/wiki/File:Velha_Fiando_(1904)_-_Jos%C3%A9_Malhoa.png, Public Domain). Bottom: *The Three Spinsters* (1886) by Walter Crane in *Household Stories by the Brothers Grimm* (http://www.gutenberg.org/ebooks/19068, Public Domain).

Figure 7. Sequence of video stills of a woman spinning flax, approximately 3-4 seconds. Note slightly oblique, mediolateral guiding of flax fibers. Stills originate from video by Alice Bernardo (https://www.saberfazer.org/), used with permission.

Figure 8. Woman wetting flax fibers while hand spinning. Photographs by Alice Bernardo (https://www.saberfazer.org/), used with permission.



Supplemental Figure 1. Monte do Vale do Ouro 2 right I_2. A) Mesial view used for measurement of groove. B) Mesial view with annotations of measurements taken. C) Lateral view used for measurement of groove. B) Lateral view with annotations of measurements taken.



Supplemental Figure 2. Monte do Vale do Ouro 2 Left I_2. A) Mesial view used for measurement of groove. B) Mesial view with annotations of measurements taken. Note that blue line used for measuring the labiolingual length of the groove accounts for postmortem damage to lingual root surface. C) Lateral view used for measurement of groove. B) Lateral view with annotations of measurements taken. Note that blue line used for measuring the labiolingual length of the groove accounts for postmortem damage to lingual root surface.

Supplemental Figure 3. Monte do Vale do Ouro 2 Right I_2 interactive 3D photogrammetry model. Original photographs and photogrammetry files available on Zenodo (http://doi.org/10.5281/zenodo.4293770).

Supplemental Figure 4. Monte do Vale do Ouro 2 Left I_2 interactive 3D photogrammetry model. Original photographs and photogrammetry files available on Zenodo (http://doi.org/10.5281/zenodo.4293770).