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A history of violence in the Mesolithic female skeleton from Mezzocorona-Borgonuovo (Trento, northeastern Italy)

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Abstract

Scholars have long been interested in understanding conflict in prehistoric times. Skeletal lesions attributable to interpersonal violence constitute the most direct evidence available to make inferences on the diachronic changes in the frequency, scale, and motivation for conflict among human communities. It has been proposed that evidence of violence becomes more common among Early Holocene Mesolithic hunter-gatherers; however, the skeletal record becomes increasingly fragmentary in more ancient periods, making the finding of new evidence of great importance. We present here a case of traumatic recidivism in a Mesolithic female from the site of Mezzocorona-Borgonuovo (MBN-1) in the northeastern Italian Alps (Trento). This female displays a perimortem perforating defect in the frontal bone, as well as healed cranial and forearm fractures. Although it is possible to interpret these injuries as resulting from falls from height, we propose that they are most compatible with MBN-1 being victim over time of multiple episodes of interpersonal violence. In addition, probably a few months before death, MBN-1 suffered another traumatic injury of the ankle, and in this case the fall from height appears the most likely scenario. We further propose that the attacks leading to the cranial and forearm fractures were presumably perpetrated by individuals coming from outside MBN-1's group. Conversely, her group most likely cared for her through medical treatment – as suggested by the successful healing of forearm and ankle fractures – and by according her a formal burial. The traumatic history of MBN-1 provides rare glimpses into the life experience of a Mesolithic female from northeastern Italy, a context where human remains are extremely rare. However, being a single case, more findings are needed to understand whether or not MBN-1 can be viewed as emblematic of the overall exposure to interpersonal or accidental trauma for Mesolithic groups in the area, and to explore issues of frequency, origin, and motivation for ancient conflict.

Keywords

Prehistoric conflict, interpersonal violence, hunter-gatherers, trauma, Holocene, Europe,

1. Introduction

Violence and warfare are topics that simultaneously exert a deep fascination and strong repulsion on people. The recognition that conflict and warfare have been long present in our prehistory has led researchers to attempt an understanding of the reasons and consequences of this human activity, which appears to have involved a significant level of collective action, energy expenditure, and – depending on the society – military organization. Not surprisingly, early warfare has been a topic of significant interest and research in anthropology, leading to a large body of literature exploring it from a materialistic, evolutionary, sociological and historical theoretical perspective (e.g. Keeley, 1996; Ferguson, 1997; Wrangham, 1999; Guilaine, Zammit, 2001; Otto et al., 2006; Fagan et al., 2020; reviews in Thorpe, 2003; Kim and Kissel, 2018; Kissel and Kim, 2018; Leblanc, 2020).

Although the theoretical discussion is ongoing, most scholars agree that bioarchaeological data provide the most direct evidence of past interpersonal violence, and contain a wealth of environmental, economic, social, technological, and cultural information on the individuals and groups that waged or suffered war (Haas, 1999; Walker, 2001; Thorpe, 2003; Christensen, 2004; Martin et al., 2012; Knüsel and Smith, 2014a,b). As such, burials and human remains often constitute the starting point of the analyses of prehistoric conflict, to be integrated with further contextual evidence such as the presence of specialized weaponry, fortifications, and other material proxies for warring activities (Vencl, 1999).

Various scholars have proposed specific prehistoric periods in which it is possible to detect an increase in the frequency or scale of conflict in the bioarchaeological record, for example the diffusion of the Neolithic (Christensen, 2004; Smith, 2014; Knüsel and Smith, 2014b;

Schulting and Fibiger, 2012). Some researchers suggest that evidence of violence becomes more common as early as the Mesolithic, the period between the end of the Pleistocene ca. 10,000 BCE to the adoption of a Neolithic lifestyle (e.g. Frayer, 1997, Thorpe, 2000, 2003; Vencl, 1999; Walker, 2001). Indeed, there is ample evidence in Europe of Mesolithic interpersonal violence, with assemblages of human remains interpreted as massacres (Balakin and Nuzhnyi, 1995; Frayer, 1997; Thorpe, 2003; Orschiedt, 2005; Estabrook, 2014; reviews in Keeley, 1996; Guilaine and Zammit, 2001), and traces of other behaviors potentially related to conflict, such as evidence of cranial trophies on stakes (Schulting, 2013; Gummesson et al., 2018). Still, other scholars point out that these kinds of diachronic evaluations are likely to be biased by the skeletal record becoming increasingly fragmentary in older periods, and propose similar trauma prevalence between these periods and the Upper Paleolithic (Roksandic, 2004; Beier et al., 2021). Other potential biases lie in the often-difficult interpretation of archaeological assemblages: Roksandic (2004) suggests that the often-cited massacre at Ofnet could have other – even diachronous – explanations, especially considering the lack of high-quality excavation documentation. Furthermore, trauma does not always imply intentional violence, and evidence of violent interactions are not necessarily proof of organized violence, or even warfare.

The study of violence in the past is thus limited by fragmentary and problematic evidence, depicting a partial and often contrasting scenario. In this context, the finding of new evidence can provide substantial information, especially when it involves multiple episodes of violence. In this paper, we present a case of traumatic recidivism in a Mesolithic female from Mezzocorona-Borgonuovo (Trento, northeastern Italy). The history of trauma and violent interactions experienced by this individual is analyzed from skeletal evidence, which – together with contextual archaeological data on the local socio-environmental conditions – allows for glimpses into issues of frequency and origin of violent interactions among Holocene foragers in the Alpine area.

1.1 Archaeological context and purpose of the study

The Mesolithic burial of Mezzocorona-Borgonuovo (Trento, Italy) was discovered in 1995 at the foot of a Dolomitic formation in the Adige Valley (Figure 1) (Dalmeri et al., 2001, 2002). Above the Mesolithic layers, the site presented levels from the Early and Middle Neolithic of the area (Bazzanella et al., 2000; 2001), and evidence of Copper Age and Bronze Age burials (Nicolis, 1996; 2001; 2004; Mottes and Nicolis 2019). The burial, henceforth abbreviated to MBN-1, consists of an individual lying supinely with lower limbs extended and the hands placed in the pelvic area (Figure 2). More than 40 dolomitic stones of various sizes were placed around and above the body, some of which presented traces of ochre (Dalmeri et al., 2001, 2002). Several pieces of red ochre were found in the fill of the pit, especially in the thoracic area; no other grave goods were directly associated with the burial. At the time of excavation, the skeleton was fragmentary and extremely fragile, requiring extensive consolidation *in situ*.

[Figures 1 and 2 about here]

The attribution of this burial to the Mesolithic was based on stratigraphic evidence (Dalmeri et al., 2001, 2002), as well as on similarities in funerary treatment with the other Mesolithic burials in the area, such as Mondeval de Sora (Gerhardinger and Guerreschi, 1989; Fontana et al., 2020) and especially Vatte di Zambana (Corrain et al., 1976). However, the precise chrono-cultural context within the Mesolithic was not entirely certain. The pit was dug in layers attributed to the Early Mesolithic (Sauveterrian) (from the Early Holocene to the beginning of the 7th millennium BCE). In contrast, three radiocarbon dates on human bone placed the individual in the second half of the sixth millennium BCE, and therefore within the late Castelnovian chrono-cultural phase, spanning from about 7000 BCE to the Neolithic transition, which was established in the Adige Valley around the beginning of the fifth millennium BCE (Mottes, 2021). Conversely, one date (ETH-15980) overlaps with the early Neolithic of the region (Table 1). This variability cannot be attributed to contamination from substances that were used to consolidate the skeleton during excavation because sampling for these dates was performed before consolidation (Dalmeri et al., 2001; see also Sedlmeier and Kaufmann, 1996:145; Sparacello et al., 2019, 2020b, 2021). Outside the burial structure, to the East of the skull stratigraphic unit (SU) 151 contained selected faunal remains (part of an antler and four mandibles of red deer, i.e. *Cervus elaphus*) with traces of reddish coloring, which may have been associated with the funerary behavior. The date of one of these elements (MBN-186, 5515-5216 BCE) overlaps with the oldest date obtained on human bone (5474-5222 BCE; Table 1), but a stratigraphic relationship with the burial was absent. Conversely, a *terminus post quem* was provided by another faunal element from the Sauveterrian layer (SU 148) into which the burial pit (6742-6481 BCE; Table 1) was made.

[Table 1 about here]

The discovery of Mezzocorona is particularly important because direct skeletal evidence of the paleobiology and adaptations of Mesolithic humans from the northeastern Italian Alps is rare, consisting of only two other burials. The assemblage consists of Vatte di Zambana, a female attributed to the Sauveterrian, discovered less than 10 km south of Mezzocorona (direct date KIA-12442, 7943±46 uncal BP, 7036-6690 BCE 95.4% probability; Corrain et al., 1976; Dalmeri et al., 2002), and c. 80 km east, the burial of a male from Mondeval de Sora (San Vito di Cadore, Belluno), attributed to the Castelnovian (direct date OxA-7468, 7425±55 uncal BP, 6429-6121 BCE; Gerhardinger and Guerreschi, 1989; Fontana, 2006; Fontana et al., 2020). In the rest of northern Italy, only an infant from Arma Veirana (Liguria) was recently published (Hodgkins et al., 2021), and coeval remains from the nearby Arma di Nasino are under study (Sparacello et al, in progress). Conversely, several Mesolithic burials have been found in southern Italy (Sicily; Sparacello et al., 2020a).

The purpose of this study is to provide a biological profile of the MBN-1 burial, focusing especially on the pathological changes, which can help in reconstructing the history of trauma in this individual, and by extension, can shed light on the lifestyle and social interactions of these Alpine Mesolithic communities (cf. Milner, 1995; Walker, 2001; Roksandic, 2004; Armit et al., 2007; Knüsel and Smith, 2014a). In order to clarify the chronological context of this fundamental burial, a new AMS radiocarbon date was performed.

2. Materials and Methods

The remains of Mezzocorona-Borgonuovo 1 are curated at storage facilities of the Superintendency for Cultural Heritage of the Autonomous Province of Trento, Italy. Although fragmentary, all regions of the skeleton are preserved (Figure 2; Table 2). The basicranium and facial skeleton have been reduced to minute fragments and parts of them did not survive. This includes the maxilla, although several maxillary teeth were retrieved, while the mandible is virtually complete. Various vertebral bodies, ribs, metacarpals, metatarsals and phalanges are either missing or fragmentary.

[Table 2 about here]

The traumatological assessment of the injuries found in MBN-1 was based on macroscopic and radiographic analysis. Perimortem lesions were distinguished from taphonomic breakage based on the appearance of the surface, margins, and outline of the fracture (Ubelaker and Adams, 1995; Knüsel, 2005; Cattaneo and Cappella, 2017). Descriptions were based on the protocols developed by Roberts (1991) and Grauer and Roberts (1996) for trauma analysis in paleopathology, and interpretation of the mechanism of injury was based on the forensic, medical, and paleopathology literature (e.g. Lovell, 1997; Galloway, 1999; Ambade and

Godbole, 2006; Kimmerle and Baraybar, 2008; Court-Brown et al., 2015; Buckely et al., 2017; Hahn and Chong, 2017). The left forearm and the left fibula were X-rayed at the Radiology Unit of the Policlinico GB Rossi in Verona (Italy). All skeletal elements were photographed, and surface 3D models of the main skeletal elements were created using a structured-light scanner (DAVID ® SLS-3, DAVID Group 2007-2015). The 3D models were uploaded to MorphoSource, a freely accessible online repository for 3D data provided by Duke University, USA (https://www.morphosource.org/projects/000477119?locale=en).

Methods used for the assessment of biological sex were drawn from Buikstra and Ubelaker (1994) for cranial and pelvic morphology, and Bruzek (2002) for the pelvic morphology. Mandibular ramus flexure was also used, following Loth and Henneberg (1996).

Age was estimated using cross-referencing data from suture closure (Meindl and Lovejoy, 1985), changes in the auricular surface of the ilium (Buckberry and Chamberlain, 2002), dental development (AlQahtani, 2010), dental wear compared to other hunter-gatherers (Lovejoy, 1985), and fusion of epiphyseal growth plates (methods compiled in Schaefer et al., 2009; see also Belcastro et al., 2008; Lottering et al., 2017; Bartolini et al., 2018).

The tooth partially damaged for AMS dating and molecular analyses (in progress) was the maxillary right second molar. In order to preserve the morphology of the specimen, before transverse sectioning below the cemento-enamel junction (CEJ), all sides of the tooth were photographed at high resolution, a cast of the crown was taken using a silicone mold for dentistry, and a µCT of the whole tooth was carried out at the 3D Imaging Lab of the Senckenberg Centre for Human Evolution and Palaeoenvironment (SHEP), Eberhard Karls University at Tübingen.

Radiocarbon dating was performed at the Curt-Engelhorn-Center Archaeometry gGmbH in Mannheim, Germany, using a MICADAS-type AMS system. Collagen content and quality were checked according to international standards (C:N ratios between 2.9 to 3.6, DeNiro, 1985; %C>40%; collagen % >1%).

3. Results

3.1 MBN-1 biological profile and radiocarbon date

Despite the partial preservation of cranial remains, and the severely crushed pelvis, an attribution of the skeleton to that of a female appears reasonable. Following the standards compiled by Buikstra and Ubelaker (1994), cranial features were scored as “2” (superior nuchal line robusticity, supraorbital margin, glabella) or “3” (mastoid process). Mandibular features were scored as “1” (mental eminence and gonial angle appearance). The gonial angle is greater than 90 degrees, and mandibular ramus flexure is absent bilaterally.

Only one pelvic feature could be scored following Buikstra and Ubelaker (1994), which supports a female assessment: the greater sciatic notch was scored as 2 on the right side, while the scoring of the left side is uncertain (but below 3) due to damage in the preauricular area. The same damage prevented the scoring of the preauricular sulcus, which is partially visible on the right side. Following Bruzek (2002), the greater sciatic notch could be evaluated on the right side and corresponds to the typical female form (f-f-f). The presence of a typically female composite arc formed by the sciatic notch and the auricular surface can be assessed bilaterally (Supplementary Information Figure S1 and model in MorphoSource).

Age-at-death could be estimated to be adult based on the development of the third molar (root apex closed, age >22.5 years; AlQahtani et al., 2010). Cranial sutures were beginning to fuse in the anterior sagittal (score 2), bregma (score 1), and pterion regions (score 2), while they were open (score 0) at midlambdoid, lambda, obelion, and inferior sphenotemporal. Damage prevented the observation of the midcoronal, sphenofrontal, and superior sphenotemporal sutures. The composite score for the vault ranges between 5-14, with an interdecile age estimate range of 23-65 years. The auricular surface of the right ilium was scored as Stage IV (composite score 12), following Buckberry and Chamberlain (2002), giving an age estimate range of 29-81 years. Of the epiphyses that fuse in early adulthood, only the iliac crest could be examined, although the region shows abundant taphonomic damage. The posterior part of the epiphysis appears incompletely fused in the left *os coxae,* with an epiphyseal line discernible on the medio-ventral aspect, and the epiphyseal surface visible in the posterior region close to the superior posterior iliac spine (Supplementary Information Figure S2). This would correspond to a stage V in Lottering et al (2017; see also Bartolini et al., 2018), suggesting an age below 25 years. Another partially unfused region preserved in MBN-1 occurs between the first and second sacral bodies, but it has been demonstrated that this kind of appearance can be retained in adulthood (“a” pattern in Belcastro et al., 2007; Supplementary Information Figure S3).

Dental wear could be examined in the posterior maxillary dentition and in the anterior mandibular dentition. On the contrary, the maxillary teeth from the first premolar to the first incisor are absent bilaterally, together with the corresponding maxillary alveolar bone. Conversely, mandibular teeth from the second premolar to the third molar were lost antemortem bilaterally (Table 2). The anterior dentition was scored as “D-E” following Lovejoy (1985), which would correspond to an age between 20 and 30 years, although the canines show more wear than incisors. The posterior maxillary dentition shows only polishing on the third molar, and very little dentine exposure in the first and second molars, corresponding to a score of “D-E” and an age between 20-30 years, following Lovejoy (1985) or 17-25 years, following Brothwell (1981). Surviving premolars show more advanced wear, and were scored as “H” (40-50 years). However, wear is influenced by antemortem tooth loss, and the loss of the mandibular molars may have slowed down the rate of wear in maxillary molars while increasing the rate in premolars. If this is the case, a younger age estimate based on the posterior dentition (especially the unworn third molar) probably correlates more with the age at which MBN-1 lost the posterior mandibular dentition, rather than with age-at-death.

The new radiocarbon date, 6538±29 BP (MAMS-56784), respects the standards for the quality of the collagen (C:N = 3.24; %C = 43.1; collagen % = 4.9). Calibrated with OxCal 4.4.4 using the IntCal20 calibration curve (Bronk Ramsey, 2023; Reimer et al., 2020), the 95.4% confidence interval for the date is 5612-5409 BCE (i.e. ~7500 years before present).

3.2 Description and possible mechanism for the skeletal lesions

3.2.1 The cranium

As mentioned above, the cranium of MBN-1 is incomplete and fragmentary, presenting several “dry bone” breakages, most likely caused by the pressure of the stones placed to cover the burial (see below). However, at least three depressions appear to have been caused by another mechanism.

In the right portion of the frontal bone, it is possible to identify a perforating defect consisting of a well-defined “D-shaped” fracture of the cranial vault, with traces of scalloping along the anterior ectocranial edge, and extensive internal beveling of the endocranial margin (Figure 3). Lack of bone reaction indicates a perimortem lesion. Radiating fractures follow lines of least resistance often observed for trauma at this position: two extend towards the spheno-frontal suture, one towards the coronal suture, and opposite to these, two others radiate into the frontal bone (e.g. cf. Orschiedt et al., 2003; Roksandic et al., 2006; Kroman et al., 2011; Cybulski, 2014:425; Fibiger, 2014:137; Ríos et al., 2014:632; Smith, 2014:116; Chenal et al., 2015; Janković et al., 2017). The presence of what appears to be a chop-mark crossing the defect (Kimmerle and Baraybar, 2008:291) is in fact due to an uncommonly large non-metric trait (frontal grooves and foramina; Mann et al., 2016:16; Figure 3), and is not related to the injury. The perimortem lesion observed in MBN-1 likely resulted from a blunt force, or possibly from a sharp-blunt force injury (see experimental work in Moreno-Ibáñez et al., 2023). Given the position of the defect in the cranium above the “hat brim line”, the semi-ovoid shape (Kremer et al., 2008; Kremer and Sauvageau, 2009; Guyomarc’h et al., 2010; Kranioti, 2015), and the absence of other postcranial perimortem fractures usually associated with a fall from height (McRae and Esser, 2008; Court-Brown et al., 2015; Buckley et al., 2017), the lesion was most likely acquired in the context of interpersonal violence, and accomplished using a blunt object (e.g. Dyer and Fibiger, 2017; cf. the traces of scalloping in Figure 3 and Supplementary Information Figure S4 with Figure 4.17 in Kimmerle and Baraybar, 2008:162), or a sharp-blunt object such as an adze (see experimental work in Moreno-Ibáñez et al., 2023). Although it is impossible to determine the possible co-occurrence of other soft-tissue injuries in vital organs, the severe trauma to the brain was probably also the cause of death (see Knüsel and Smith, 2014a:10; Saukko and Knight, 2016).

[Figure 3 about here]

In addition to the perimortem injury, MBN-1 also displays healed antemortem trauma. Two depressed cranial fractures with smooth margins can be observed, in the right and left parietal bones, both near the sagittal suture (A and B in Figure 4; the smaller depression B is best observed in the surface 3D model of the cranium due to the dark color of the bone). In the right parietal, the defect A has an oblong-spatulate shape (c. 36 mm long), composed of a circular depression with a diameter of c. 14 mm and a maximum depth of c. 2 mm, which extends anteriorly into a shallower funnel-like depression c. 8 mm wide. The bottom of the depression has a clearly linear appearance (Figure 4). No signs of radiating fractures are present. Defect B in the left parietal is semi-circular, with a diameter of c. 11 mm, and a depth of c. 1.5 mm. No evident alteration of the endocranial surface is present which corresponds with these two defects.

[Figure 4 about here]

Similar lesions are commonly interpreted as healed blunt force trauma (e.g. Walker, 1989; Cohen et al., 2012; Schulting, 2012:229; Smits, 2012:196; Fibiger et al., 2013; Glencross and Boz, 2014; Walshe et al., 2016), although certain circular depressions have been attributed to completely healed trepanations (Alt et al., 1997; Lillie, 1998; Crubézy et al., 2001). Congenital and developmental defects can also produce unifocal or multifocal vault thinning (Kaufman et al., 1997: Barnes, 2012:11; Partiot et al., 2017). The defects observed in MBN-1 are most likely due to the relatively low-velocity impact of a blunt object, leading to incomplete depressed non-penetrating fractures (e.g. Dyer and Fibiger, 2017). Similar to the previously described perimortem lesion, the shape and the position of the defects in the cranium are more suggestive of a blow, rather than a fall (Kremer et al., 2008; Guyomarc'h et al., 2010; but see Henriques et al., 2023). The absence of perforation, or displacement of the bone plugs, facilitated the complete healing (e.g. Ortner, 2003:135; Barbian and Sledzik, 2008; Kimmerle and Baraybar, 2008:160). Based on the advanced stage of healing, and the smooth appearance of the defects, the lesions were in the remodeling stage, and likely occurred years before death of MBN-1 (Lovell, 1997). Given the similarity in position and degree of remodeling of these lesions, a parsimonious, yet untestable, interpretation would be that the two healed cranial defects originated from the same violent encounter, and are therefore part of a patterned complex of lesions, possibly including also the forearm fractures (see below; Cybulski, 2014). Interestingly, the articular facets of the cervical vertebrae of MBN-1 are quite asymmetric (when both sides can be observed; Supplementary Information Figure S5), and display a "flattened pancake shape" degeneration on the left side (Van Vlasselaer et al., 2017), which also could be related to previous cranio-cervical trauma (Uhrenholt et al., 2008; Kulvatunyou et al., 2012).

3.2.2 The upper limb

The left radius and ulna of MBN-1 display abnormal medially-oriented curvature with onset around the midshaft (Figure 5). The deformity is not present on the right side, and no bowing is observable in weight-bearing elements, making the differential diagnosis of rickets unlikely (Brickley and Ives, 2008). This points towards a traumatic origin, either a plastic bowing deformity or the result of healed fractures (Stuart-Macadam et al., 1998). The latter seems more likely, also considering a discontinuity in the cortical bone of the ulna that is observable radiographically (arrow in Figure 6). Therefore, the ulnar curvature may have resulted from a healed transverse fracture, while the degree of flattening and deformation of the radius (best observable in the 3D model) suggests a healed oblique or spiral fracture (Lovell, 1997; Kellam, 2017; Figure 5). Overall, it appears that MBN-1 had sustained ante-mortem diaphyseal fractures, most likely resulting from the same traumatic event, based on the similar level of the lesions when the elements are articulated (i.e. slightly proximal of the diaphyseal midshaft; Figure 5). Contemporaneity of the fractures is also suggested by both defects being at a similarly advanced stage of healing and remodeling at the time of death (Lovell, 1997; Gueorguiev-Rüegg and Stoddart, 2017), and coherent dysplasia of the fractured elements. The degree of shortening in length cannot be determined due to epiphyseal damage in both bones, although radiographic investigation suggests that apposition was almost complete (Figure 6). Both bones fused with a slight medial and posterior angulation (ca. 5°), while rotation cannot be appreciated due to damaged epiphyses (the 3D surface models of the articulated forearms of MBN-1 can be visualized and downloaded from MorphoSource). The mineralized callus had been resorbed and is no longer visible; bone remodeling was under way at the time of death, with extensive bone apposition along the diaphysis (Figure 6). This suggests that the trauma occurred from a few to several years prior to the death of MBN-1 (Lovell, 1997).

[Figures 5 and 6 about here]

The position and the transverse nature of the ulnar fracture suggest a blunt force that impacted the ulna posteriorly, and perpendicularly to the long axis of the bone. This mechanism of injury is common when the forearm is in pronation, and held up to shield from a blow directed at the head (i.e. a “parry fracture”; review in Judd, 2008; Kimmerle and Baraybar, 2008:173). The oblique appearance of the fracture in the radius, and its position roughly between the insertions of two antagonistic muscles (*M. supinator* and *M. pronator teres*), suggest that it originated from an indirect force, possibly the same that was directly applied to the ulna. Involvement of the radius in parry fractures is rare, but has been observed, and appears to depend on the force of the blow (Judd, 2008; Kimmerle and Baraybar, 2008:173). Another mechanism generating a simultaneous fracturing of the ulna and radius would be a “paired rotational fracture”, which results from a fall on the outstretched hand (Judd, 2008). While this mechanism is possible in the case of MBN-1, especially considering the lower limb trauma (see below), the indirect forces involved in this type of fracture would generate oblique or spiral fractures in the ipsilateral elements, and the breaks would be at different levels, with the ulnar fracture significantly more distally positioned then the radial one, and gross rotational and angular deformity would be more apparent (Key and Conwell, 1942; Judd, 2008).

3.2.3 The lower limb

The left fibula of MBN-1 displays a bony callus resulting from a simple diaphyseal compound suprasyndesmotic fracture (White and Bugler, 2015; Hahn and Chong, 2017: Figure 7), with signs of periostosis. The radiographs show that the bony callus was in the process of remodeling through the apposition of more compact lamellar bone, therefore the fracture was in the early phases of the remodeling stage. Healing time is variable and can be influenced by numerous factors, but this stage usually ensues a few months after the injury (Lovell, 1997; Shantz et al., 2015; Gueorguiev-Rüegg and Stoddart, 2017; Figure 8). This type of fracture occurs when a pronated foot sustains excessive rotation or abduction forces – typically during a fall – and results in the rupture of the anterior inferior tibio-fibular ligament and of the interosseous ligament/membrane up to the level of the fracture (Hahn and Chong, 2017:945). Accordingly, entheseal ossification is apparent in the medial aspect of the fibula of MBN-1 (Figure 7). Malunion consists of a slight lateral displacement of the distal segment, while no significant angulation or rotation is appreciable (Figures 7 and 8; see also the 3D surface model in MorphoSource). Taphonomic damage of the distal tibia does not permit the evaluation of a possible concomitant fracture of the medial malleolus and/or the posterolateral tibial lip (Volkmann's triangle), which are possible co-occurrences in this kind of injury (Hahn and Chong, 2017). Possibly related to this injury is the fusion of the middle and distal pedal phalanx in the fifth ray of the left foot, probably due to a healed fracture.

[Figure 7 and 8 about here]

3.2.4 Probable pseudo-trauma

In addition to several taphonomic dry-bone breakages throughout the skeleton, it is worth noting the presence of fractures which occurred when the bone was still rich in collagen, as apparent from the curved and sometimes sharp margins, which do not show signs of healing (Knüsel, 2005; Ubelaker and Montaperto, 2014; Cattaneo and Cappella, 2016). One of these fractures is present in the left ulna, and could be mistaken for another "parry fracture" (cf. Knüsel, 2005; Passalacqua and Fenton, 2012:402), and another is observable in the proximal left femur (Supplementary Information Figure S6). Subtrochanteric fractures are usually the result of high-energy impact during car crashes and falls from great height (Sassoon et al., 2015) and are quite rare in the bioarchaeological record (Brinker et al., 2014). However, the partially stepped and jagged appearance of the fracture lines excludes the possibility of a traumatic origin. Although partially obscured by weathering, the pattern of crushing observable throughout the skeleton, with most fractures clearly resulting from dry-bone breakage, and others showing some of the hallmarks of fresh-bone breakage (Sauer, 1998; Knüsel, 2005; Ubelaker and Montaperto, 2014; Cattaneo and Cappella, 2016) is most compatible with taphonomic processes. During the earlier stages of decomposition of the body, when empty space was created by the decomposition of the soft tissues (e.g. Duday, 2009), the compacting of the sediment and of the heavy boulders placed above MBN-1 generated bending forces on certain skeletal elements, leading to these fractures.

4. Discussion

The female Mesolithic individual from Mezzocorona-Borgonuovo had sustained multiple cranial and infracranial fractures during her life, and constitutes an interesting case of injury recidivism (Judd, 2012, 2017; see also Orschiedt et al., 2003). Based on the similar degree of healing, two cranial depressed defects and the left forearm fractures occurred a few to several years prior to death, although it is not possible to establish the concomitance of the injuries. The third, a penetrating perimortem cranial fracture, was most likely the cause of death. A few months before, MBN-1 suffered a traumatic injury to the ankle, probably resulting from a fall from height. Beyond providing further empirical evidence of the presence of lesions compatible with interpersonal violence in the Mesolithic, and insights into the mechanisms of injury, the patterned lesions in the skeleton of MBN-1, and its wider archaeological context, permit inferences about the possible circumstances of death (Roksandic, 2004; Armit et al., 2007; Schulting and Fibiger, 2012; Knüsel and Smith, 2014b).

We proposed in the previous section that, at least for the perimortem cranial defect, the most likely mechanism or mode of injury (Rogers, 2004) was blunt-force, weapon-related trauma, based on the appearance, the positioning above the “hat brim line”, and the absence of concomitant fractures compatible with a fall. Indeed, fall-related injuries rarely lie above the hat brim line if the fall occurred from a standing position (Geserick et al., 2014), and would therefore require the individual to fall from height. The two healed cranial depressed fractures reside above the hat brim line as well, and in fact are close to the cranial vertex, which would require a fall from a great height (Fracasso, 2011). In this case, it is possible that one or both depressed fractures originated from a fall if they occurred concomitantly with the left forearm fracture. However, the forearm fracture appears more compatible with a “parry fracture” rather than with a fall with an outstretched hand. Overall, although the interpretation of multiple accidents involving a fall from height is possible, we propose that these healed fractures are more likely to result from one or more episodes of interpersonal violence (e.g. Kranioti, 2015).

Making inferences about intended lethality is often challenging, especially in a bioarchaeological context. In the case of MBN-1, intent to kill can be hypothesized for the perimortem lesion, which was caused by a blow violent enough to cause a perforating cranial lesion, with probable massive brain trauma (Saukko and Knight, 2016). Regarding the earlier, healed forearm and cranial lesions, it has been suggested that high levels of healed cranial trauma could be related to ritual violence, i.e. controlled form of violent confrontation

(Thorpe, 2005:11; Schulting, 2006). Although the cranium and face are often the focus of intentional injuries (Galloway, 1999; Knüsel, 2014), Ambade and Godbole (2006) argue that blunt force trauma to the head is more often observed when killing is unintentional, while the use of a sharp object and the targeting of the abdomen is more indicative of intentional killing. However, stabbing injuries to the abdomen are under-represented in the bioarchaeological record because they often do not impact the skeleton (Knüsel and Smith, 2014b). In the case of MBN-1, intent to kill would be a likely interpretation if the healed lesions occurred concomitantly. In that situation, MBN-1 would have received at least two/three violent blows, such as to cause the fracture of both bones in the forearm, raised to protect the face, and two depressed cranial fractures above the hat brim line. In this possible scenario, even if killing was not the assailant’s primary goal, it was probably not considered a major consequence to be prevented.

In order to gain insights into the motivation for these violent acts, it would be important to reconstruct the circumstances of violence, i.e. whether the attacks originated from outside the group, or could be classified as within-group “domestic” violence (Schulting and Fibiger, 2012; Knüsel and Smith, 2014a,b). While violence can be attributed to external attacks in the case of multiple contemporary burials resulting from massacres (e.g. Meyer, 2020; Meyer et al., 2015, 2018), the interpretation in the case of MBN-1 is more tentative. A reconstruction of the type of community MBN-1 lived in may help with the interpretation of the origin of the lesions. Archaeological evidence suggests that Mesolithic people in the northeastern Alps lived in small bands of nomadic hunter-gatherers with low population densities (Grimaldi, 2005). No large settlements or cemeteries have been discovered, and high-altitude sites consisted of temporary hunting camps, mainly tracking the seasonal movements of ungulates (Fontana et al., 2009; Fontana and Visentin, 2016). Isotopic studies including that of MBN-1 confirm that the diet was mainly based on terrestrial ungulates, and secondarily on freshwater resources (Oxilia et al. 2020; Gazzoni et al., 2021). Although ethnographic analogies should be used carefully, especially given the dearth of evidence, Mesolithic hunter-gatherers from the northeastern Alps could be classified as “simple” foraging societies, as opposed to ranked or “complex” hunter-gatherers (e.g. Schulting, 1996, 2003; although the “simple-complex” dichotomy may be too simplistic, Cummings, 2013:65). Violence between and within groups is present in simple foraging societies, albeit its frequency and role are highly debated (e.g. Fry and Södeberg, 2014, Fry, 2016). Types of within-group violence observed among foragers include domestic violence against women (reviews in Draper, 1992; Kelly, 1995;

Lomas, 2009). However, cross-culturally, within-group violence is usually condemned, while violence towards other groups can be tolerated or is even encouraged (Schmidt and Schröder, 2001; Stewart and Strathern, 2002). In addition, the availability of kin and the small size of the foraging groups tend to discourage violence within groups, and other forms of conflict resolution are often preferred, such as fission (Draper, 1992; Lomas, 2009). Overall, given the social context that could be reconstructed for MBN-1, we propose that it is more likely that violence originated from outside the group.

Furthermore, the pattern of trauma and healing in MBN-1 may provide insights into the care that her group employed to treat her wounds. Direct evidence of fracture treatment in the archaeological record is rare and much later than the time of MBN-1, the earliest splints made of bark having been identified in Egyptian mummies from the fifth dynasty (ca. 2500-2300 BCE; Elliot-Smith, 1908). However, various studies have considered the degree of deformity in bones that are likely to be severely affected when fractured to make inferences on the knowledge of medical treatment, such as reduction and the application of splints, in past populations (Roberts, 1991; Grauer and Roberts, 1996; Lovell, 1997). Furthermore, ethnographic observations on traditional foraging societies report the use of fracture reduction using weights and the application of splints (Harley, 1979:95; Oyebola, 1980; review in Roberts and Manchester, 2010:315). Forearm fractures, especially when both the radius and the ulna are involved, usually lead to dislocation, rotational deformity, displacement, and eventually to malunion if not properly surgically treated (Helber and Ulrich, 2000; Judd, 2008; Streubel and Pesántex, 2015; Capo, 2017). Today, non-operative treatment of forearm fractures is essentially limited to stable distal ulnar fractures (Streubel and Pesántex, 2015). Among European Pleistocene foragers, minimal deformations and shortening can be observed in the healed distal diaphyseal ulnar fracture of Oberkassel 1 (Trinkaus, 2015) and Dolní Věstonice 15 (Trinkaus, 2005) and in the distal diaphyseal radial fracture of Caviglione 1 (Chevalier, 2019). In the case of MBN-1, the level of radius fracture, approximately between the insertion of the pronator teres and supinator muscles, is the one that generates the greatest rotational deformities (Streubel and Pesántex, 2015). Although some malunion is present in MBN-1, and rotational deformities cannot be precisely estimated due to taphonomic damage, the relatively well-healed outcome suggests that the forearm fractures were anatomically reduced and properly stabilized, most likely shortly after the injury occurred.

Similarly, the indirect compound fracture of the fibular shaft occurs in a context of dislocation of the talus, which needs to be properly anatomically reduced and stabilized, albeit surgery is not always required (White and Bugler, 2015; Hahn and Chong, 2017). Archaeological evidence of lower limb fractures among highly mobile prehistoric hunter-gatherers is rare (Trinkaus, 2011, 2012; Cowgill et al., 2012), the only healed injury that would have required a period of immobility being Vado all'Arancio 1 from the Late Upper Paleolithic of Italy, which shows a healed fracture of the talo-crural joint which affected the tibial and peroneal malleoli, and the dorsal border of the distal tibial epiphysis (Holt et al., 2002). This individual displays deformity of the distal epiphyses, significant new bone formation, and talar lateral sub-luxation, which suggest a lack of complete functional recovery of the injured limb (Holt et al., 2002). In the case of MBN-1, the fracture was healing without significant deformities and with little bone formation, again suggesting a proper fracture treatment. It is difficult to determine if the group was required to accommodate a long-term locomotory impairment (Estabrook, 2014; Tilley, 2015; Byrnes and Muller, 2017), but functional deficits in these kinds of fractures are common long-term outcomes, and are certain in the short term. In addition, MBN-1 may have suffered long-term neurological and balance deficits following traumatic brain injury, which may have led to impairment and may have contributed to subsequent trauma (e.g. Basford et al., 2003; Kaufman et al., 2006; Chandrasekhar, 2013). Finally, MBN-1 was formally buried after the fatal attack that produced the perimortem cranial fracture. Although it is not possible to directly assess the type of fracture treatment that was employed by these Mesolithic foragers, indirect evidence of medical assistance, possible accommodation of impairments, and proper funerary treatment suggest that the physical assaults are more likely to have originated from outside the social group of MBN-1.

Beyond the inference that these injuries may have resulted from intergroup conflict, it is difficult, based on one individual, to add to the debate on the scale and motivation for conflict in the Mesolithic, or whether this period sees an increase in evidence of premeditated, organized violence, feuding, or even warfare (e.g. Vencl, 1999; Thorpe, 2000, 2003; Estabrook, 2014; but see Roksandic, 2004, 2006). A simple answer is probably impossible, given that the European Mesolithic encompassed a variety of social and technological systems (Estabrook, 2014), and that the degree of social complexity and stratification seems to correlate with the scale and motivation for violent interactions (e.g. Fry, 2006; Cummings, 2013). While the bioarchaeological record may suggest that deadly violence increased in the Mesolithic as a whole (Estabrook, 2014), local conditions differ in the variegated European landscape. In areas such as Brittany, southern Scandinavia, and the Danubian Iron Gates, permanent or semi-permanent settlements suggest limited mobility and high population density, while large cemeteries and elaborated mortuary practices hint at increased social complexity (e.g. Mithen, 1994; Schulting, 1996; Crombé and Robinson, 2009; Boulestin, 2016; Grünberg, 2017). In those places, several cases of healed and unhealed cranial trauma, projectile injuries, and parry fractures have been observed (e.g. Bennike, 1985, 1997; Balakin and Nuzhnyi, 1995; Walker, 2001; Roksandic, 2004; Orschiedt, 2005; Gummeson et al., 2018), fueling the debate over the scale and motivation of Mesolithic conflict. In other areas, such as northern Italy, where subsistence and burial practices – and presumably social organization – seem to share more in common with the Upper Paleolithic (e.g. Tolan-Smith, 2008), lack of evidence leads to an assumption of lack of complexity (Cummings, 2013). It has been proposed that small groups of highly-mobile hunter-gatherers – such as the ones to which MBN-1 belonged – would be organized in "simple" unsegmented societies (Hill et al., 2011), lacking the organizational features associated with planned conflict (Kelly, 2000). In this context, conflict would be episodic, spontaneous, and over resources (Kelly, 2000:158). Accordingly, some Mesolithic evidence of violence has been associated with rapids and mountain passes (Balakin and Nuzhnyi, 1995; Lillie, 2004), where hunting and foraging is favored by the presence of several ecological niches in a small area (Guilaine and Zammit, 2001). The finding of MBN-1 near the confluence of two rivers (the Adige and the Noce) may therefore indicate that the ecological richness of the area triggered conflict between groups of hunter-gatherers.

Whether Mesolithic intergroup conflict could be defined as "war" essentially depends on the definition provided by various authors, often based on scale, duration, and motivation of sustained aggression (e.g. Reyna 1994; Keeley, 1996; Kelly, 2000; Thorpe, 2003). However, a definition proposed by Kelly (2000) seems particularly appropriate to pre-state societies and is based on the principle of "social substitutability", i.e. "*the principle that one group member is substitutable for another in these contexts underwrites the interrelated concepts of injury to the group, group responsibility for the infliction of injury and group liability with respect to retribution*" (Kelly, 2000:5). Injuries inflicted to non-warriors, including children, would suggest that this principle was applied by the aggressors. In the case of MBN-1, we can hypothesize a non-warrior status, especially considering the probable physical limitations dictated by previous injuries. The death of this individual would have therefore happened in a context of prehistoric warfare or feuding, according to Kelly's (2000) definition.

The age at which MBN-1 died may provide insights into the frequency of traumatic and violent events among Mesolithic people in the northeastern Alps, and on the developmental phase at which MBN-1 incurred trauma. Estimating age-at-death once skeletal development is concluded is notoriously problematic, all methods presenting considerable limitations (review in Ubelaker and Khosrowshahi, 2019). While MBN-1 was certainly an adult at the time of death – as indicated by skeletal and dental development, and by the commencement of cranial vault sutural fusion – her apparently partially unfused posterior iliac crest suggests the possibility of a young adult age (less than ca. 25 years). This would suggest that the earlier trauma occurred when MBN-1 was a late adolescent. However, the iliac crest in MBN-1 is heavily altered by taphonomic damage, perhaps mimicking an open epiphysis. The other methods employed to estimate age-at-death could not resolve the issue. Dental wear, which could be compatible with a young adult estimate, is highly dependent on the diet, and methods developed using different hunter-gatherer groups (Lovejoy, 1985) may provide an inaccurate estimate when applied to a single individual. Moreover, the lack of significant wear in the maxillary posterior dentition is probably due to the early loss of mandibular molars, which probably occurred shortly after the eruption of the third molar. Overall, a conservative age estimate for MBN-1 would be "adult", which does not permit more precise assessment of the timing of earlier trauma.

Given the chronology suggested by the radiocarbon dates, the possibility that MBN-1 may represent evidence of violent contact between local late Mesolithic and early Neolithic groups should be discussed. Knüsel and Smith (2014b) note the overwhelming evidence of depressed cranial injuries with the same ovoid shape and general position of MBN-1 in Neolithic Europe (e.g. Schulting and Fibiger, 2012; Fibiger et al., 2013; Smith, 2014; Chenal et al., 2015; Meyer et al., 2018), and suggest that violent confrontations may have been included in the "Neolithic package" to facilitate demic diffusion (see also Cahen, 1985; Keeley, 1996, 1997; Christensen, 2004; Golitko and Keeley, 2006). Clear evidence of this "frontier conflict" has not been directly confirmed by skeletal evidence (e.g. Roksandic, 2006; Roksandic at al., 2006; Smith, 2014). However, Neolithic individuals who may have succumbed to attacks by other local Mesolithic groups have been reported (Jeunesse et al., 2019; Alt et al., 2020). Regarding Mezzocorona, at the current stage of research, there is no convincing archaeological evidence supporting a similar scenario. The direct date obtained in this study for MBN-1 (ca. 5600-5400 BCE) is compatible with the oldest date previously obtained on the skeleton, and supports the idea that the coeval red deer mandibles stained with ochre were associated with the funerary treatment afforded MBN-1 (Dalmeri et al., 2001, 2002). This would place this individual within the Late Mesolithic (Castelnovian), while archaeological evidence – such as the filling of the pit containing lithic industries typologically attributed to the Sauveterrian – would be compatible with an even earlier chronology (Dalmeri et al., 2001, 2002). The Neolithization of the Adige valley is still little documented, but it has been hypothesized that local Mesolithic groups may have gradually adopted a Neolithic lifestyle (e.g. Bagolini 1980; Bazzanella et al., 2000; Mottes, 2013). According to various scholars, the second half of the sixth millennium BCE would constitute an “availability phase” (Zvelebil and Rowley-Conwy, 1984) for the Mesolithic groups of the Alpine region, during which some elements of the Neolithic economy were adopted within a substantially Mesolithic lifestyle (Bazzanella et al., 2000; Mottes, 2021). However, the earliest Neolithic sites in the Adige Valley appear only at the beginning of the fifth millennium BCE (Mottes, 2021), at least half a millennium after the burial of MBN-1. Although Neolithic settlements were established from the second half of the sixth millennium BCE in the Po Plain (Pearce, 2013; Starnini et al., 2018), the earliest evidence of possible contact between late Mesolithic and Neolithic colonizers comes from the site of Ala Le Corone (ca. 60 km south of Mezzocorona), where domestic cereal kernels have been found in late Castelnovian layers dated to the last quarter of the sixth millennium BCE (Mottes, 2021). At the same site, no such evidence has been found in layers coeval to the date of MBN-1 presented here (Nicolis et al., 2007; Mottes, 2021). The findings from the site of Romagnano (Loc III, ca. 20 km south of Mezzocorona), where a layer dated to ca. 5530-5330 BCE included Castelnovian Mesolithic lithic tools and Neolithic tools and pottery (Broglio, Kozlowski, 1984; Bazzanella et al., 2000; Fontana et al., 2016) should be disregarded, as it has been demonstrated that the presence of pottery resulted from an admixture with later stratigraphic layers (Pearce, 2013; Bazzanella et al., 2000; review in Mottes, 2021).

Still, further studies on the chronology and archaeological context of MBN-1 are necessary. As mentioned above, the various dates obtained for this individual show a wide range of variability, suggesting caution in making inferences based on the one obtained in this study. Future methodological improvements, for example compound-specific radiocarbon dating of collagen amino acid (hydroxyproline), may clarify this intriguing issue (Gazzoni et al., 2021).

Regardless of the origin of the attack, it could be argued that evidence collected from the remains of MBN-1 – who, according to our interpretation, experienced at least two instances of weapon-related violent attack during her lifetime – would suggest that intergroup violence was more frequent than an occasional for these small and highly-mobile Mesolithic communities (Orschiedt et al, 2003; Schulting, 2013; Knüsel and Smith, 2014b; Kissel and

Kim, 2018). Moreover, another burial dated to the Sauveterrian in the area, Vatte di Zambana, has been included in reviews of Mesolithic evidence of trauma possibly related to violence, based on radio-ulnar trauma reported in previous catalogues (Estabrook, 2014, citing Newell et al., 1979). However, the direct examination of that skeleton suggests a more complex scenario of possible multiple traumatic events and pathological deformities, possibly related to a congenital and/or degenerative condition that requires further investigation (Corrain et al., 1976; Sparacello et al., 2018a). Interestingly, the third Mesolithic burial in the area, Mondeval de Sora, displays pathological changes throughout the skeleton that have been attributed to a systemic pagetoid condition (Alciati et al., 1994, 1997). It cannot be excluded that, rather than being representative of the normal life experiences of Mesolithic people in northeastern Italy, these individuals may have been buried by virtue of their exceptional nature, in continuity with funerary practices that have been proposed for the earlier Upper Paleolithic. In several studies, many Gravettian and Epigravettian burials (Middle and Late Upper Paleolithic) are interpreted as the expression of ritual behaviors aiming at ritually containing or sanctioning “exceptional people and exceptional events”, based on pathological afflictions, trauma, and violent events (Formicola, 2007; Pettitt, 2013; Sparacello et al., 2018b, 2021; Trinkaus, 2018; Trinkaus and Buzhilova, 2018; Jeunesse 2021:320; Knüsel et al. 2023). In this light, MBN-1 would therefore provide an indication of the social importance of repeated trauma and violent interactions for these small bands of hunter-gatherers, rather than informing on the frequency of violence. The finding of further evidence is necessary to estimate the prevalence of conflict in the Mesolithic of the northeastern Alps.

5. Conclusions.

Although definitive inferences should not be drawn from a single individual, especially in bioarchaeological studies, the traumatic history of the female from Mezzocorona is compatible with a scenario of multiple violent interactions experienced by a Mesolithic forager in the Adige valley. Although other interpretations of the pattern of trauma are possible, including multiple accidents, we propose that, over several years, she was attacked repeatedly, and eventually fatally, by individuals presumably coming from within or outside her group. Conversely, her group most likely cared for her through medical and ritual treatment. The proximate and ultimate reasons for these episodes of violence remain unknown, but this rare case of traumatic recidivism, provided that the life experience of MBN-1 was representative of her group, contributes to the debate regarding the frequency of conflict among Mesolithic foragers.

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Tables

Table 1

Sample ID	Lab. N°	Analyzed Material	SU	Uncal. BP	$\delta^{13}C$	Cal. BC 95.4%
MBN-208	ETH-15980	MBN-1 human bone (right rib fragment)	145	6005±75	-21.0±1.2	5206-4713
MBN-209	ETH-15981	MBN-1 human bone (left hand phalanx)	145	6170±70	-22.0±1.2	5306-4938
MBN-254	UtC-7202	MBN-1 human bone (diaphyseal fragments, femur, indet.)	145	6210±60	-23.3	5307-5008
MBN-255	UtC-7201	MBN-1 human bone (diaphyseal fragments, humerus, femur)	145	6380±50	-23.8	5474-5222
MBN-186	ETH-15984	Animal bone (*Cervus elaphus* mandible)	151	6410±75	-24.1±1.2	5515-5216
MBN-US 148	KIA 12446	Animal bone (*Cervus elaphus* mandible)	148	7797±43	-21.1±0.15	6742-6481

Table 1 – Previous radiocarbon dates obtained on human remains from the burial of Mezzocorona-Borgonuovo and from the fauna found in layers (SU: stratigraphic unit) cut by the burial pit (SU 148) or that could be associated to the funerary behavior (SU 151). Calibrated using OxCal v 4.4 (Bronk Ramsey, 2021, atmospheric data from Reimer et al., 2020). Reported calibrated age ranges correspond to 95.4% probability.

Table 2

Skull osteological composition	**Dental catalogue**	**Infracranial osteological composition**
Frontal (d); parietal (d/d); occipital (d); temporal (d/i); zygomatic (d/i); sphenoid (ff); fragments (>20); mandible (i).	ULM3, ULM2, ULM1, ULP2, URP2, URM1, URM2, URM3, LLC, LLI2, LLI1, LRI1, LRI2, LRC (cast), LRP1.	Clavicle (d/d); scapula (d/d); sternum (f); humerus (d/d); radius (d/d); ulna (d/f); carpals (5i/6i); metacarpals (5f/5f); hand phalanges (13i,d,f/13i,d); cervical vert. (2i, 3f, 2ff); thoracic vert. (4d, 6f; >10ff); lumbar vert. (3f, 2ff); *os coxae* (d/d); sacrum (d); coccyx (f); ribs (24 f, ff); femur (d/i); tibia (d/d); fibula (d/d); patella (i/i); tarsals (7d/7d); metatarsals (5d/3i, 1d, 1f); foot phalanges (5i, 8d, 1f); foot sesamoids (3i).

Table 2 – Osteological composition and preservation of MBN-1. Skeletal composition is indicated in parentheses (left/right element, and number of elements as appropriate): i: intact or minimally damaged; d: damaged; f: fragmentary; ff: small fragments. Teeth legend: I: incisor; P: premolar; M: molar; R: right; L: left; d: deciduous; U and L: indicate the maxilla (upper) or mandible (lower) tooth (e.g. URI1: upper right first incisor).

Figure 1 – A) The geographic location of the Trentino-Alto Adige region in Italy (image modified from https://d-maps.com/carte.php?num_car=4830&lang=en © 2007-2023 https://d-maps.com); B) The geographic location of the town of Mezzocorona in the Trentino-Alto Adige region (image modified from https://d-maps.com/carte.php?num_car=8324&lang=en © 2007-2023 https://d-maps.com); C) Aerial view of the location of the rock shelter where MBN-1 was found in the locality Borgonuovo (Archives of the Office for Archaeological Heritage of the Autonomous Province of Trento).

Figure 2 –A) Zenithal picture of the burial of MBN-1 in situ before removal (Archives of the Office for Archaeological Heritage of the Autonomous Province of Trento, photo taken by Alberto Bernardi); B) Drawing of the burial of the MBN-1 in situ before removal (Archives of the Office for Archaeological Heritage of the Autonomous Province of Trento, drawing by Alberto Bernardi).

Figure 3 – Different views of the perimortem injury in the frontal bone of MBN-1. A) Picture of the full cranium (scale in centimeters); B) the same view as A of the 3D surface model of the cranium (scale in centimeters); C) Close-up of the ectocranial view of the D-shaped lesion. The scalloping is visible in the lowermost portion of the lesion (scale in centimeters and millimeters); D) The endocranial view of the D-shaped lesion, showing beveling of the inner cranial table.

Figure 4 – Views of the healed cranial fractures in the parietal bones of MBN-1. A) Superior view of the right parietal showing the oblong-shaped healed depressed fracture (circled); B) Superior view of the 3D surface model of the cranium, showing the circular healed depressed fracture in the left parietal (arrow).

Figure 5 – Anterior (A) and posterior (B) views of the left radius and ulna, showing in both bones the abnormal medially-oriented curvature with onset around the midshaft. Scale in centimeters.

Figure 6 – Inverted greyscale X-rays of the left radius and ulna (A: lateral; B: anterior views). The arrow indicates the level at which cortical discontinuity can be appreciated in the ulna, suggesting a healing fracture rather than a plastic bowing deformity. Scale in centimeters.

Figure 7 – Views of the distal third of the left fibula (A: anterior; B: lateral; C: posterior; D: medial), showing entheseal ossification (white arrow) and the healing callus (red arrow). Scale in centimeters.

Figure 8 – Inverted greyscale X-rays of the distal third of the left fibula (A: anterior; B: lateral views). The arrow indicates the level of the healing callus. Scale in centimeters.

Figure 1

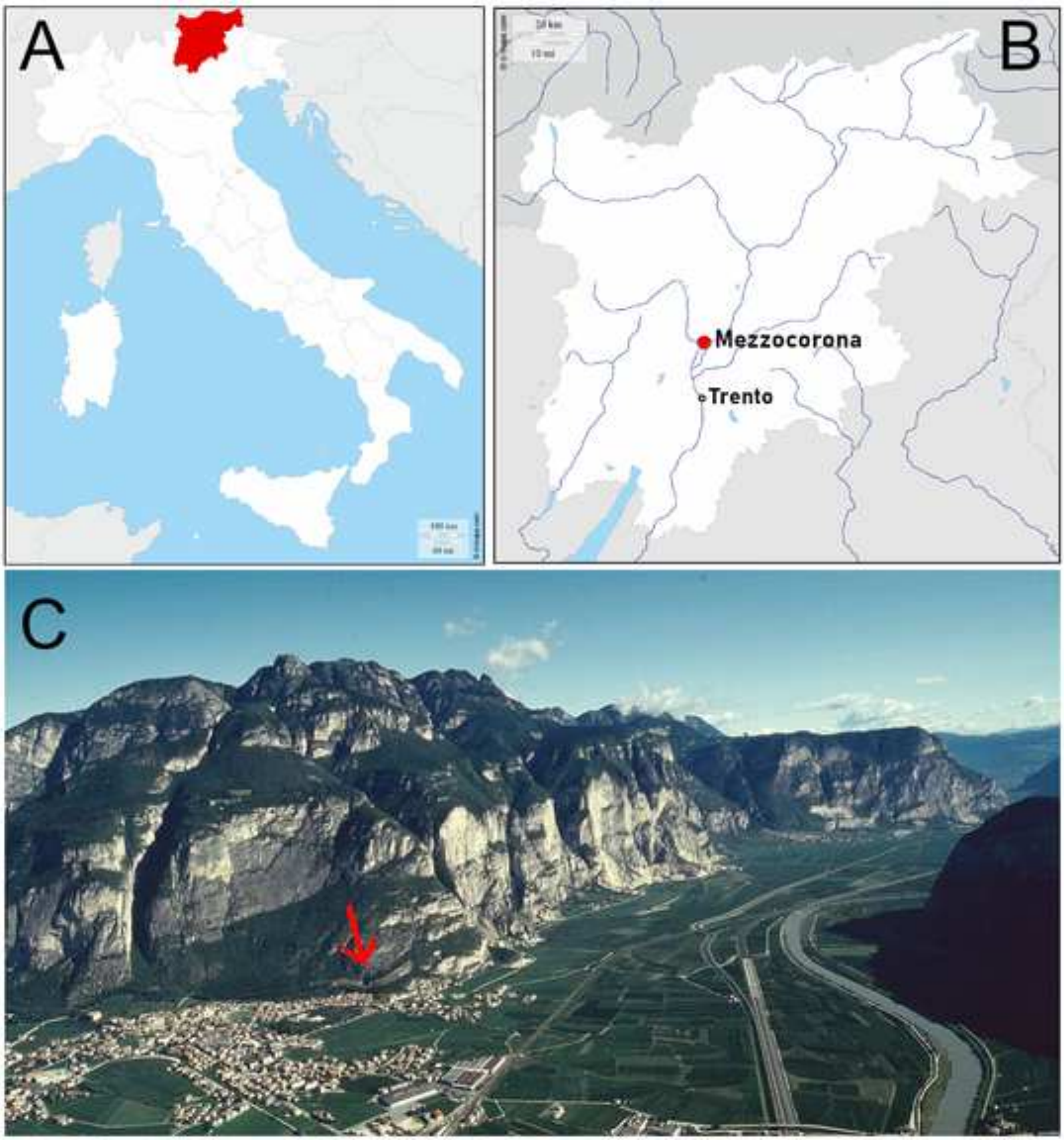


Figure 2

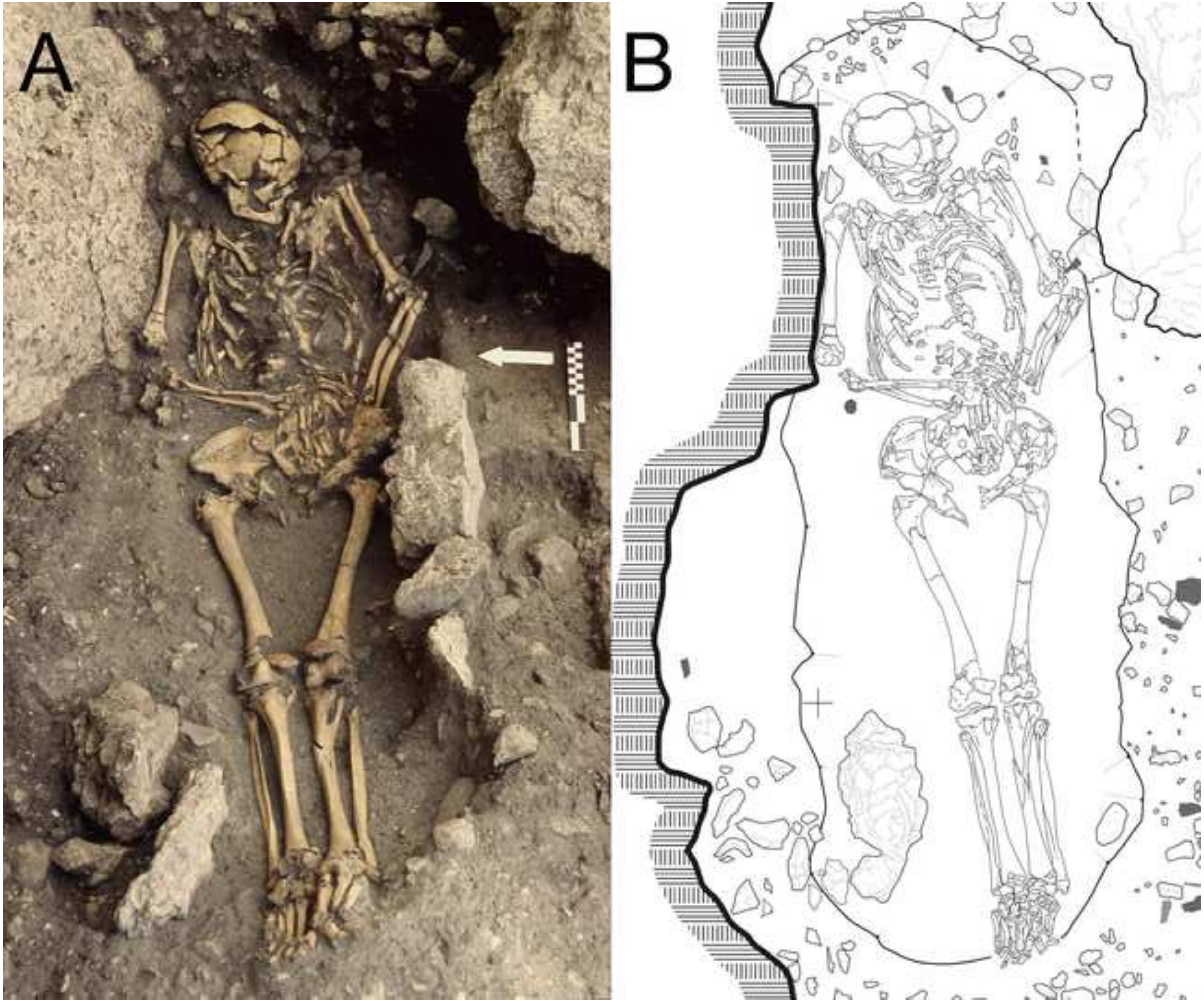


Figure 3

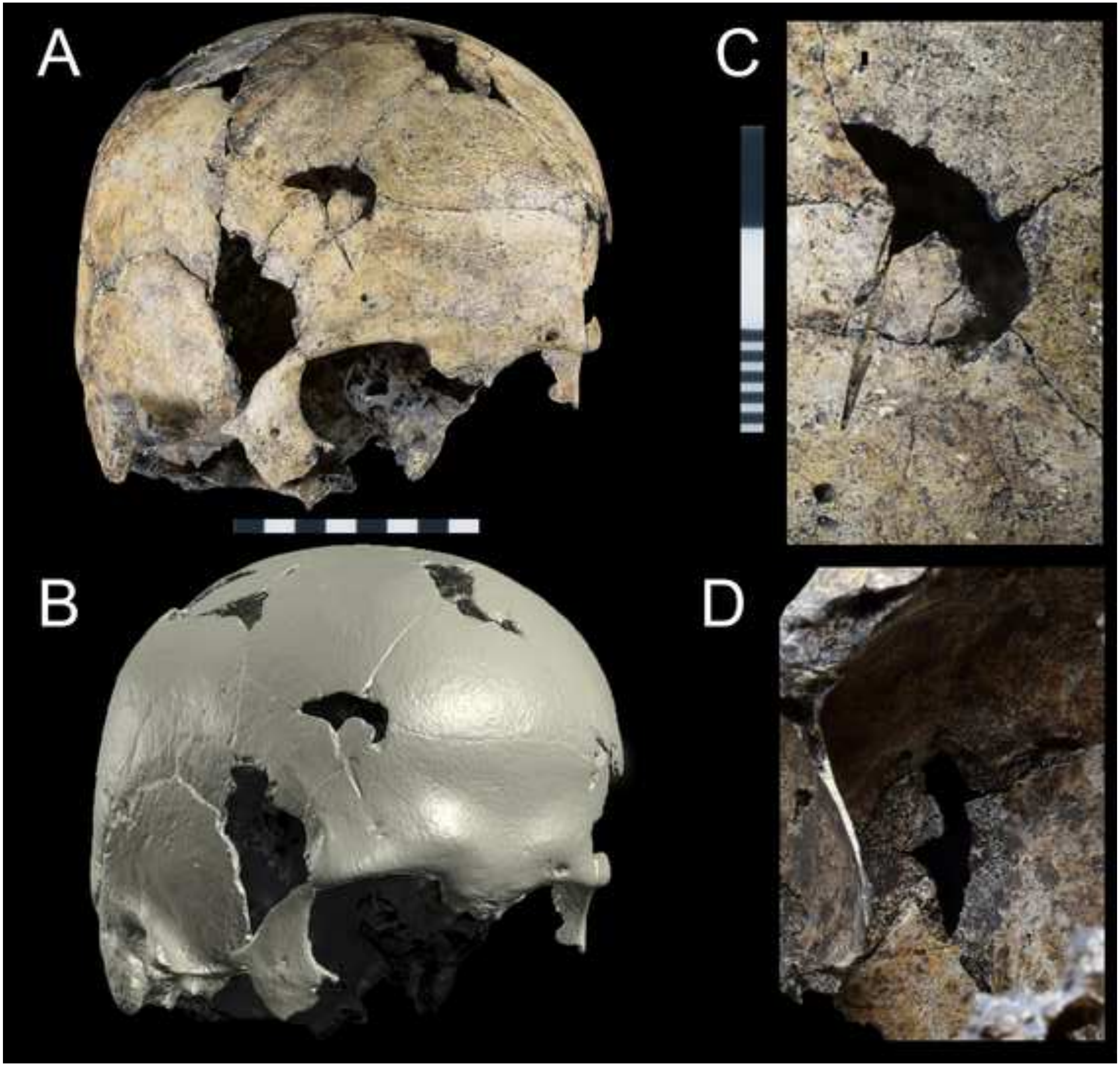


Figure 4

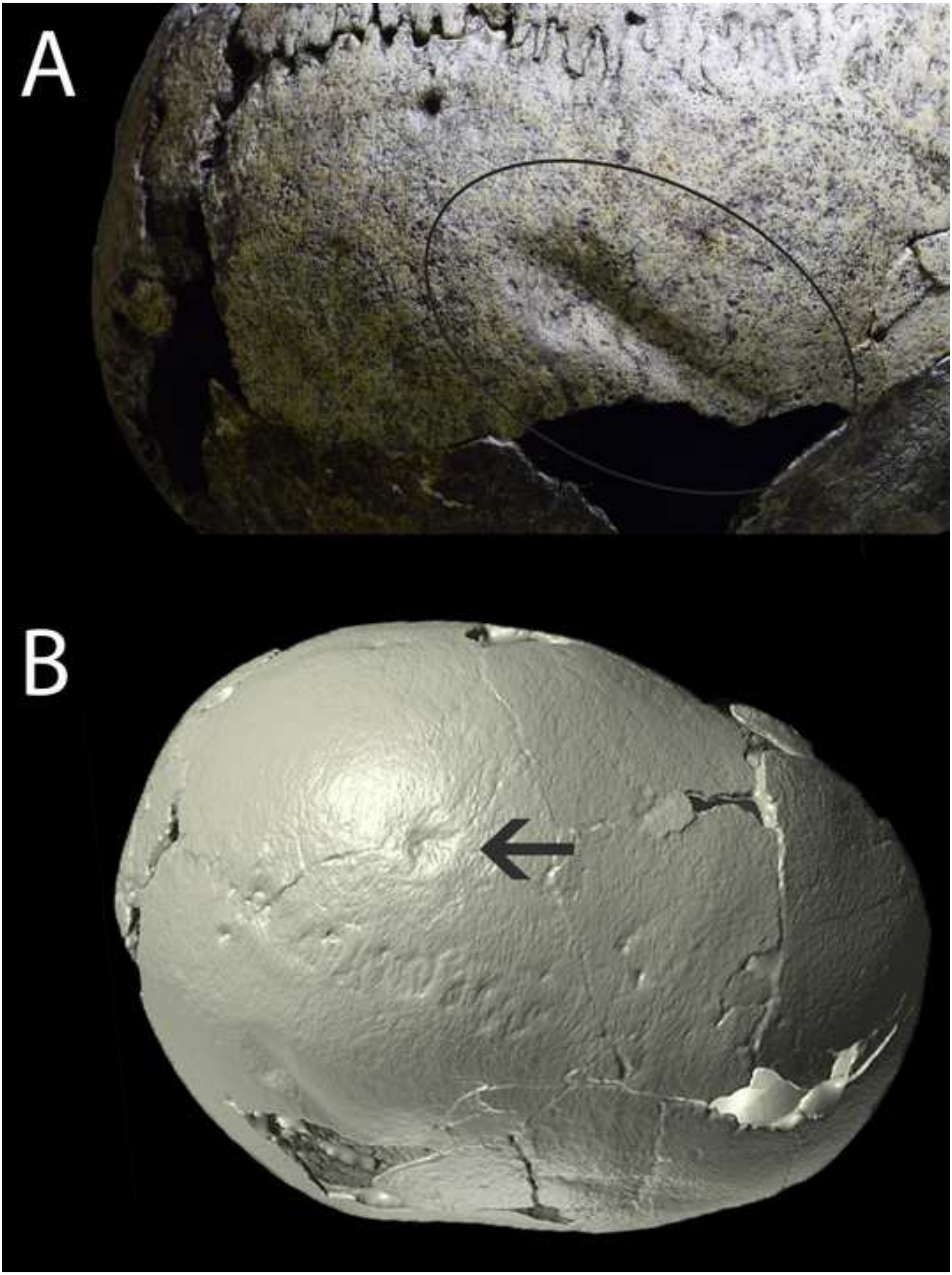


Figure 5

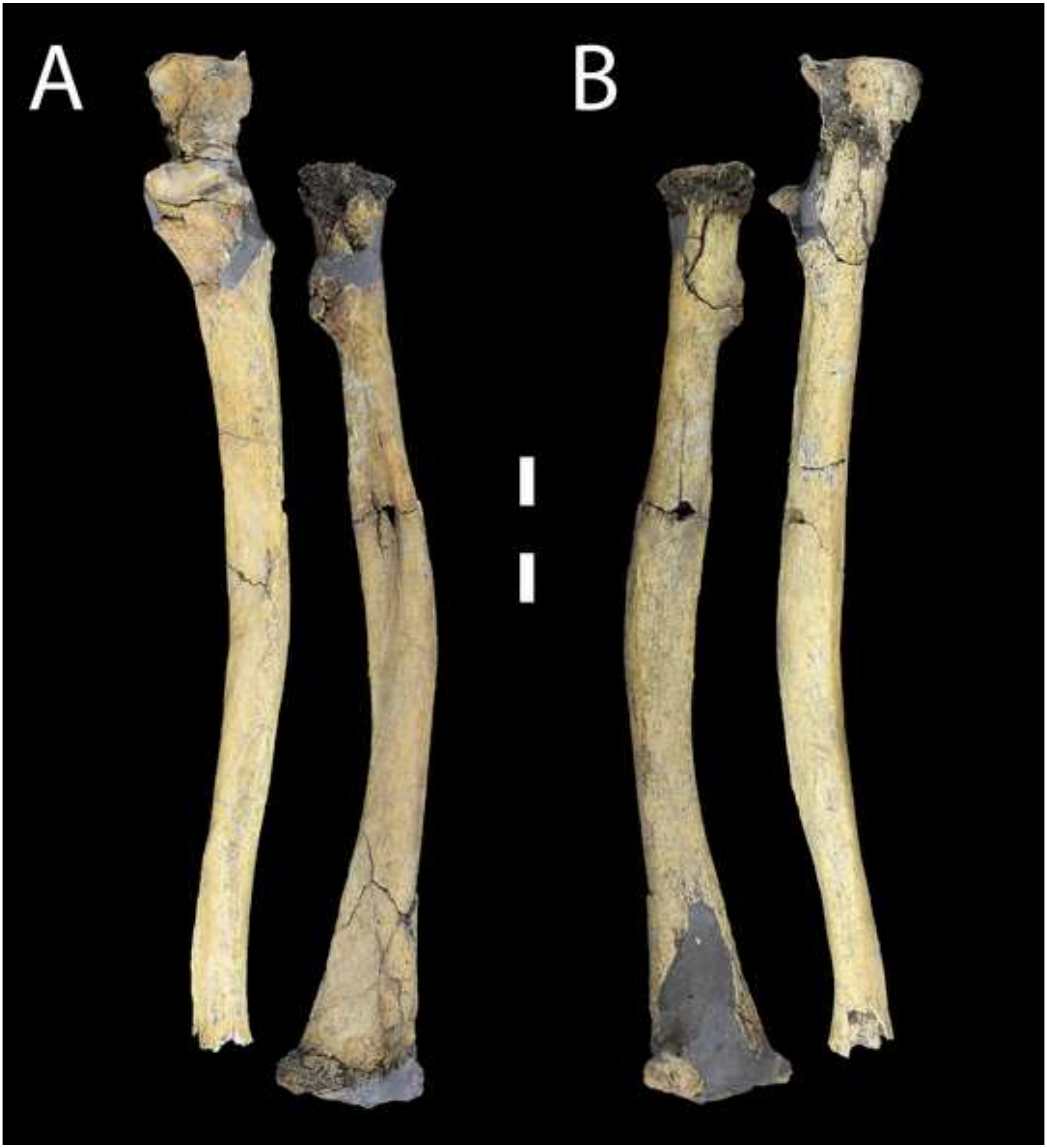
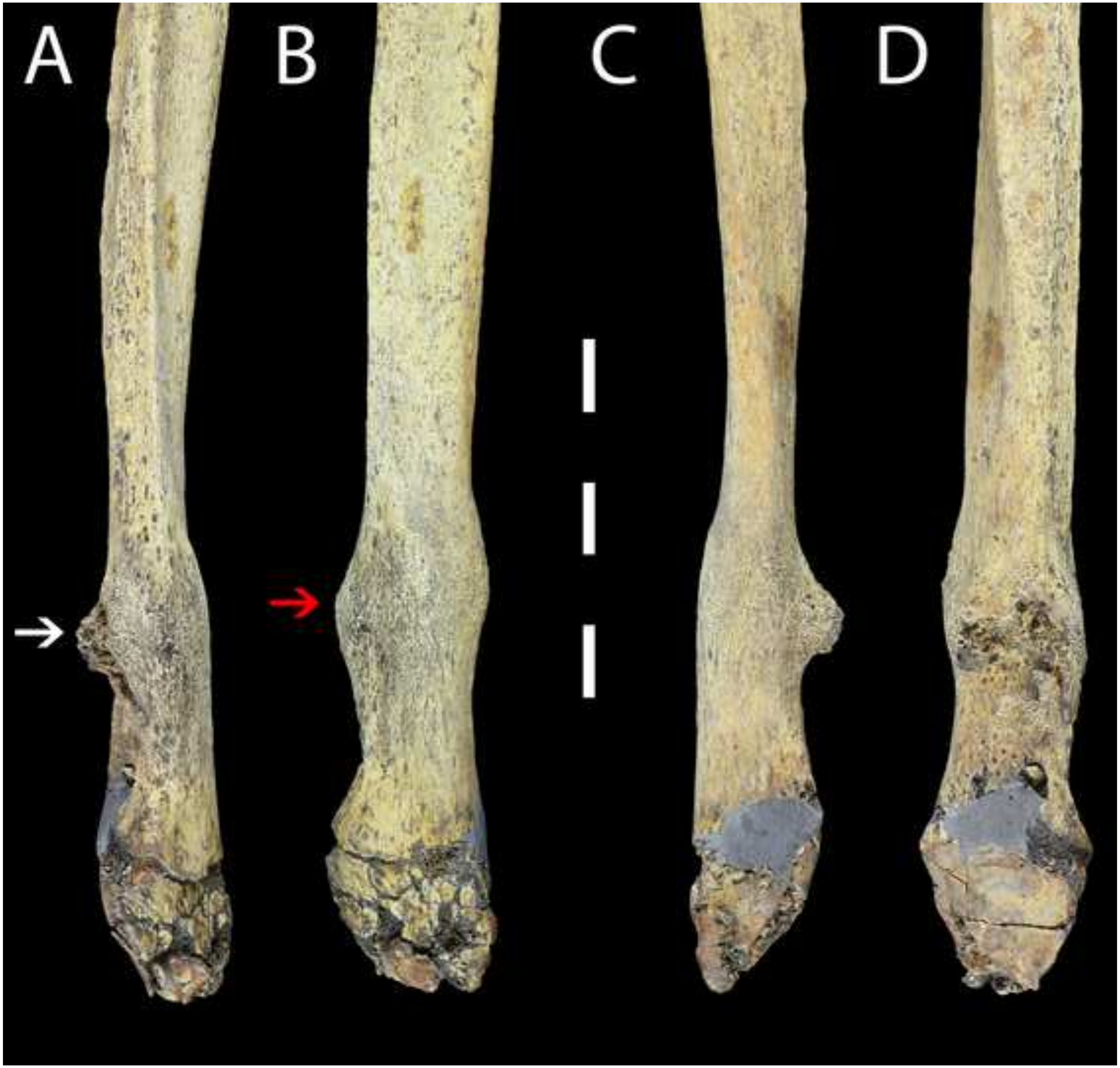


Figure 6

Figure 7




A
B