




Research Article

Disarticulation, evisceration and excarnation: Neolithic mortuary practices at Dingsishan, southern China

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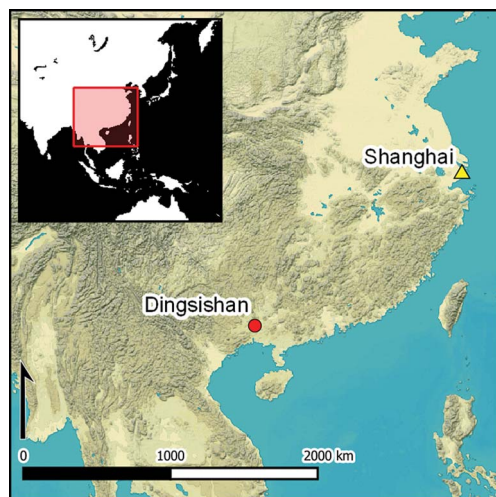
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The diversity of human mortuary practices and treatments in prehistory is widely recognised, but our understanding of the purpose and manner of corpse manipulation in many regions is limited. This article reports on unusual aspects of funerary archaeology at the Neolithic site of Dingsishan, southern China. Anatomical consideration of cutmarks on human bones and the positioning of bodies and body parts within burials suggests that mortuary treatments at this site included strategic and systematic disarticulation, evisceration and excarnation. Rather than signalling social differences, these practices may have resulted from the very practical need to save space.

Keywords: Southeast Asia, Neolithic, Dingsishan culture, corpse treatment, mortuary practice, cutmarks

Introduction

Mortuary practices, both modern and ancient, vary substantially around the world and a growing awareness of multistage practices in prehistory is enhancing our understanding of mortuary treatment globally (Robb *et al.* 2015; Crozier 2018; Kerner 2018; Daubaras 2020). One factor to consider when discussing corpse manipulation and multistage burial is whether such practices are the result of funerary processes or of non-funerary activities such as perimortem violence or post-funerary exhumation and reburial. The funeral process or ‘funerary cycle’ (Weiss-Krejci 2011) is a transitional period between the biological death and the social death of an individual, during which the living rearrange their lives and mourn the dead. The cycle may consist of several stages, including preparation or treatment of the

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body, a temporary or final deposition and extended funerary rites that take place after burial (Weiss-Krejci 2011). Each of these stages can leave its marks on the body and may thus be archaeologically traceable. As the treatment of the body is an important aspect of the funerary cycle, it provides a lens for understanding the funerary practices and rituals of the archaeological culture in question (Duday *et al.* 2009; Crozier 2018; Kerner 2018).

Another factor that must be considered is intentionality, as the body can also be altered accidentally (Knüsel 2014). When intentional, modifications to the body provide effective and convincing evidence for the reconstruction of post-mortem treatment (Lorkiewicz 2011; Mazza *et al.* 2018; Mariotti *et al.* 2020). These anthropogenic taphonomic signatures can take a variety of forms and reflect combinations of changes to the corpse, such as post-mortem decapitation, evisceration (removal of the organs of the abdomen and thorax), dismemberment and the artificial restoration of body shape (Weiss-Krejci 2011). Evidence for deliberate body treatment can also be derived from reconstructions of butchery techniques based on the distribution and direction of cutmarks (Pickering & Hensley-Marschand 2008).

Archaeological evidence for deliberate modification of corpses and multistage burial processes has been found in many regions of the world, particularly in Mesolithic and Neolithic contexts (Aufderheide 2003; Boz & Hager 2014). Some of the earliest evidence comes from Tafalalt in Morocco, where bones dating to 15 000–12 000 BP bear physical traces of dismemberment and defleshing (Mariotti *et al.* 2016). Post-mortem decapitation is apparent in the Pre-Pottery Neolithic of the Near East, such as at the site of Tell Qaramel in Syria between 11 700 and 10 700 BP (Kanjou *et al.* 2015). In Neolithic Britain, excarnation and dismemberment following initial interment of human remains have been recorded in Orkney (Reilly 2003), as has decapitation at West Tump Long Barrow in Gloucestershire (Smith & Brickley 2004). Post-mortem modification of human remains has also been demonstrated at numerous Neolithic sites in continental Europe, including Lepinski Vir and Vlasac in Serbia (Wallduck & Bello 2016) and Scaloria Cave in Italy (Robb *et al.* 2015), and at the Mesolithic site of Margaux Cave in Belgium (Toussaint 2011).

In southern China, the reconstruction and interpretation of corpse treatment is not often attempted. In the past 25 years, a total of 84 graves containing individuals with deliberate disarticulation of some joints have been recorded at the Neolithic site of Dingsishan. The burials show disarticulation of the cranium or limb bones while articulation of the smaller labile joints was maintained (Guangxi Team *et al.* 1998; Kerner 2018). Scholars have argued that these bodies were actively disarticulated prior to the advance of decomposition and to interment (Fu 2002; Li *et al.* 2013). Further analysis of the pre-deposition handling of bodies at this site will allow new insights into the intentional funerary practices of this period and region.

Archaeological context

The Dingsishan site (22°43'48"N, 108°28'6"E) is a well-preserved cemetery within shell mounds and is currently the oldest known Holocene open-air site in southern China (Figure 1). Occupation appears to span four phases, of which phases II and III are identified as Dingsishan Culture (for more detailed information, see Fu 2002; Li *et al.* 2013). Despite

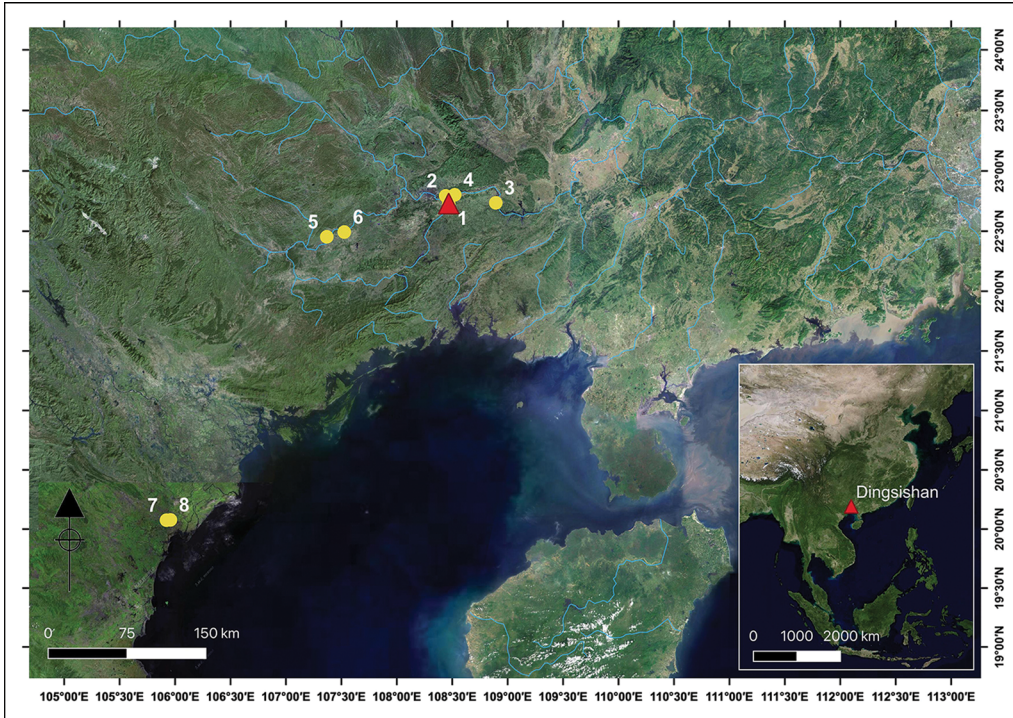


Figure 1. The location of sites in China and Vietnam with evidence for corpse manipulation: 1) Dingsishan; 2) Huiyaotian; 3) Qiujiang; 4) Lingwu; 5) Chongtang; 6) Hecun; 7) Da Bút; 8) Con Co Ngua (maps created by Z.Q. Ye using QGIS v. 3.4.7).

the calibrated date of 11 041–11 965 BP on a sample of shell for phase II at the site (Guangxi Team *et al.* 1998), there remains debate about the chronology of phase IV (dated to 6000 BP by Guangxi Team *et al.* (1998) and 4500 BP after Zhang & Hung (2012); also see Table 1). Here, we follow the typological chronology outlined in Table 1 (see Zhu *et al.* 2021). Phases I to III represent hunter-gatherers (Guangxi team *et al.* 1998; Zhu *et al.* 2021) while the presence of cultivated rice phytoliths in phase IV suggests the possibility of rice-farming (Zhao *et al.* 2005).

To date, 336 burials containing 355 individuals interred in various burial positions have been identified. Applying Knüsel's (2014) terminology to field records from the Dingsishan site, individuals are categorised in five burial positions: extended ($n = 2$); limb-flexed ($n = 113$); contracted (lower limb flexed closely to the torso and vertebral column vertically oriented, $n = 50$), hyper-flexed (beyond the normal range of movement and anatomical articulation, $n = 88$) and unidentified (fragmentary assemblages, $n = 102$). Archaeologists have suggested that limb-flexed and contracted burials are the main funerary rituals in the Early and Middle Neolithic of southern China (Zhang & Hung 2012; Li *et al.* 2013), so the presence of 88 hyper-flexed individuals in 84 burials could be interpreted as resulting from a special, intentional form of interment. Among these burials, 87 individuals in 83 burials belong to phase III and only one belongs to phase IV. According to previous burial and

Table 1. Typological, radiocarbon and calibrated dates for the Dingsishan and Huiyaotian sites.

Site/Phase	Typological date BP	Radiocarbon date BP	Calibrated date cal BP	Materials	Laboratory code
Dingsishan I	10 000 ^{a-c}	–	–	–	–
Dingsishan II	9000–8000 ^d	10 365±113 ^a	12 618–11 821 (95.4%) ^f	Spiral shell	ZK-2955
Dingsishan II	8000 ^{a-c}	10 365±113 ^a	11 041–11 965 ^{a, c}	Spiral shell	ZK-2955
Dingsishan III	8000–7000 ^{a-c}	–	–	–	–
Dingsishan IV	6000 ^{a-c}	–	–	–	–
Dingsishan IV	4500 ^{d, g}	–	–	–	–
Huiyaotian ^h	8000–7000 ⁱ	8060±40 ⁱ	9033–8847 (67.5%) ⁱ	Human tooth	BETA-429237
Huiyaotian ^h	8000–7000 ⁱ	7510±30 ⁱ	8387–8289 (71.9%) ⁱ	Charred <i>Canarium</i> seed	BETA-429238
Huiyaotian ^h	8000–7000 ⁱ	7740±30 ⁱ	8590–8430 (95.4%) ⁱ	Charred <i>Canarium</i> seed	BETA-429239

Note: a) Guangxi Team *et al.* (1998); b) Fu (2002); c) Zhu *et al.* (2021); d) Chen (2016); e) Li *et al.* (2013); f) dates modelled in OxCal v.4.4, using IntCal20 calibration curve (Bronk Ramsey 2009; Reimer *et al.* 2020); g) Zhang & Hung (2012); h) for comparison, radiocarbon and calibrated dates are also given for the Huiyaotian site, which is generally considered as a settlement strongly related to Dingsishan Phase III in the same period; i) Matsumura *et al.* (2017).

anatomical analyses, decapitation, evisceration and disarticulation of joints are features of corpse manipulation at Dingsishan, and are not restricted to hyper-flexed burials (Fu 2002). Hyper-flexed burials have been observed at five sites in Neolithic southern China (Hecun, Qiujiang, Dingsishan, Lingwu and Huiyaotian, see Figure 1), suggesting a constrained geographic distribution for this burial tradition (He *et al.* 2009; Li *et al.* 2013; Qin 2015; Matsumura *et al.* 2017). The cemeteries of the Đa Bút Culture in northern Vietnam also feature a similar pattern of depositional bodily modification to the Dingsishan site (Viet 2005; Trinh & Huffer 2015).

Several archaeological and ethnological hypotheses have been proposed to account for the abnormal skeletal representations at this site, though no thorough osteological examination has previously been reported. Qin (2010) suggests that the hyper-flexed burials found at Dingsishan are variants of limb-flexed burials: when group members died away from the site, the corpses were disarticulated, packed for convenience of transportation or release of rigor mortis, and later buried in a limb-flexed-like position. Using the historical record and ethnography of the later period of southern China as an analogy, Pan (2004) argues that disarticulation served to prevent the spirit's revenge. The arrangement of the bodies may also suggest that soft, perishable containers or quadrangular boxes were used in the burial process (Kerner 2018, Figure 2).

Such conjecture is enlightening, but a discussion of burial diversity is not the focus of this article. Instead, we analyse cutmarks on human bone from Dingsishan and how these may relate to methods of preparing bodies for interment. This study applies an integrated approach in which both archaeological and osteological information are considered in



Figure 2. Examples of hyper-flexed, contracted and limb-flexed burials at Dingsishan. M65 (deposit code), M107 and M191 are hyper-flexed burials; M59 and M34 are limb-flexed burials; M24 is a contracted burial cutting through the burial M34 (photographs by X.G. Fu; figure by Z.Q. Ye & F.J. Li).

order to reconstruct funerary processes. Field records, including descriptions, images and hand drawings of burial deposits, are reviewed as background information for the analysis of osteological modifications. Within this context, we address the following questions: Are cutmarks present on all hyper-flexed individuals? What are the details of corpse manipulation at Dingsishan (e.g. the sex or age difference)? Is there any specific selection of location within the body for manipulation? By analysing the anthropogenic modification of the skeletons, we aim to reconstruct processes of individual manipulation, including initial preparation of the body, further corpse treatment and final placement, at Dingsishan.

Materials and methods

The complete assemblage of human bone from Dingsishan was examined. A team from Sun Yat-sen University and the Institute of Archaeology at the Chinese Academy of Social Sciences completed sex and age-at-death estimation following the standards of Lovejoy (1985) and Bruzek (2002). Following the morphological criteria of Potts and Shipman (1981), we undertook initial observations with a hand lens to distinguish different types of cutmarks and to differentiate them from excavation damage, antemortem injury, animal trampling, root etching and blood vessel impressions (Fernandez-Jalvo & Andrews 2016;

McKinley & Smith 2017). To confirm the exact position of each cutmark, microscratch observation and measurement were conducted with a handheld microscope (Dino-Lite Pro AM413ZT) under a magnification of 20–50×. In conjunction with DinoXcope for MacOS, we collected high-magnification images and orientation data for the cutmarks.

The position of each cutmark was recorded relative to standard human anatomical posture (extended supine). Referring to Pickering and Hensley-Marschand's (2008) criteria of measurement, cutmark angles equate to the degree of excursion from parallel relative to the long axis of the specimen, regardless of the distal or proximal end of the bones (0–180°, whereby 0° denotes a mark which is parallel to the bone long axis and pointing to the distal end, and 180° denotes a mark parallel to the long axis but pointing to the proximal end). Under DinoXcope software, measurements were made twice on each mark and the average was taken as the final result following the criteria above (see online supplementary material (OSM) Table S1).

In this study, corpse manipulation was determined by representation of burial position and osteological observation. To evaluate any age- or sex-based preferential manipulation of individuals, percentage prevalence of cutmarks in different age-at-death categories were calculated, and Chi-square tests were performed to examine the relationship between estimated sex and evidence of manipulation using the SPSS Statistics software (v. 19.0). Various human behaviours may 'mark' bones, including slicing, chopping, gnawing and puncturing (Shipman 1981). To avoid *a priori* assumptions of specific intent, the term 'cutmark' is used here as a general term for marks made by artefacts, as defined by Potts and Shipman (1981).

Results

Palaeodemographic information on manipulated corpses

The 88 individuals with hyper-flexed burial positions are classed as manipulated corpses, as the degree of joint flexion in the skeletons exceeds that achievable during normal motion. Microscratch observation identified cutmarks on 54 of the hyper-flexed individuals. Two individuals buried in a contracted position (M131 & M213) and one individual with an unknown burial type (M134-3) also bore cutmarks. A total of 91 skeletons from phases III and IV may therefore be classed as manipulated remains, including 54 males, 22 females and 15 unidentified individuals. The Chi-square test indicates no significant difference in the sex of skeletons that were manipulated ($\chi^2 = 1.866$, $p = 0.172$) compared with the overall population of phases III and IV (males = 169, females = 92). Table 2 shows that manipulation was most prevalent among individuals between the ages of 24 and 55 (80.77% of the known-age individuals). This indicates that manipulation was not constrained by the sex of an individual but was primarily reserved for adults.

Types of modification marks

Microscratch observation found 212 cutmarks on 57 individuals at the Dingsishan site. The cutmarks can be categorised into three types. Scraping marks were identified in 13 cases (6.13%) on 11 individuals (Figure 3a & b). They were found on the exterior of the ribs,

Table 2. Comprehensive information on manipulated individuals at Dingsishan.

Age category	Male	(%)	Female	(%)	Unknown sex	(%)	Total	(%)
0–6	0/0	0.00	0/0	0.00	2/23	8.70	2/23	8.70
7–14	0/1	0.00	0/1	0.00	2/12	16.67	2/14	14.29
15–23	4/26	15.38	5/15	33.33	2/6	33.33	11/47	23.40
24–35	22/59	37.29	10/39	25.64	0/3	0.00	32/101	31.68
36–55	22/52	42.31	5/27	18.52	4/7	57.14	31/86	36.05
55 +	0/3	0.00	0/3	0.00	0/0	0.00	0/6	0.00
Total	48/141	34.04	20/85	23.53	10/51	19.61	78/277	28.16
Sub-adult ^a	0/0	0.00	0/0	0.00	0/1	0.00	0/1	0.00
Adult ^b	6/35	17.14	2/19	10.53	5/23	21.74	13/77	16.88
Total	54/176	30.68	22/104	21.15	15/75	20.00	91/355	25.63

Note: number of manipulated individuals/ total individuals in each category; unknown age category: ^a sub-adult <18 years old; ^b adult ≥18 years old.

as well as on the diaphyses of femora, humeri and tibiae, where muscles are tightly attached. Chopping marks were identified in 20 cases (9.43%) on 11 individuals (Figure 3c) and were typically located on the posterior wall of the thorax, the neck and head of the femora, and around the elbow, in areas usually covered by thick layers of ligaments and tendons. The remaining 179 examples (84.43%) are slicing marks (Figure 3d–g), exhibiting relatively simple structures; all are fine, short lines with V-shaped cross-sections (Shipman 1981). In 96 instances, multiple slicing marks were found around muscle attachment sites, particularly on the patellae, vertebrae, clavicles and scapulae. Similarities in the morphology of slicing marks between skeletons suggest that modifications were made by the same kind of tool, possibly the sharp-edged tektite or obsidian tools that abound at the Dingsishan site (Li *et al.* 2013; Kerner 2018).

Distribution of the cutmarks

The distribution of cutmarks is summarised below by body segment (n denotes the number of cutmarks). No cutmarks were observed on the bones of the cranium or mandible (Figure 4, Tables 3 & S1).

Axial skeleton:

Ribs (n = 37). The greatest density of cutmarks is found around the thorax. Three scraping marks (one each on M38, M126-1 and M193, see Table S1), located on the exterior of the thorax, may be the byproduct of neck and shoulder disarticulations. Other cutmarks are scattered on the inferior aspects of the fourth to twelfth ribs, demarking the posterolateral thoracic cavity (n = 34). Excavation reports demonstrate that at least 15 individuals were found with skulls interred within the thoracic cavity; together with the cutmarks this suggests the act of evisceration. Five chopping marks on the left, right and interior of the ribs of M38 (Figure 5) indicate the force used to cut and separate this individual's viscera.

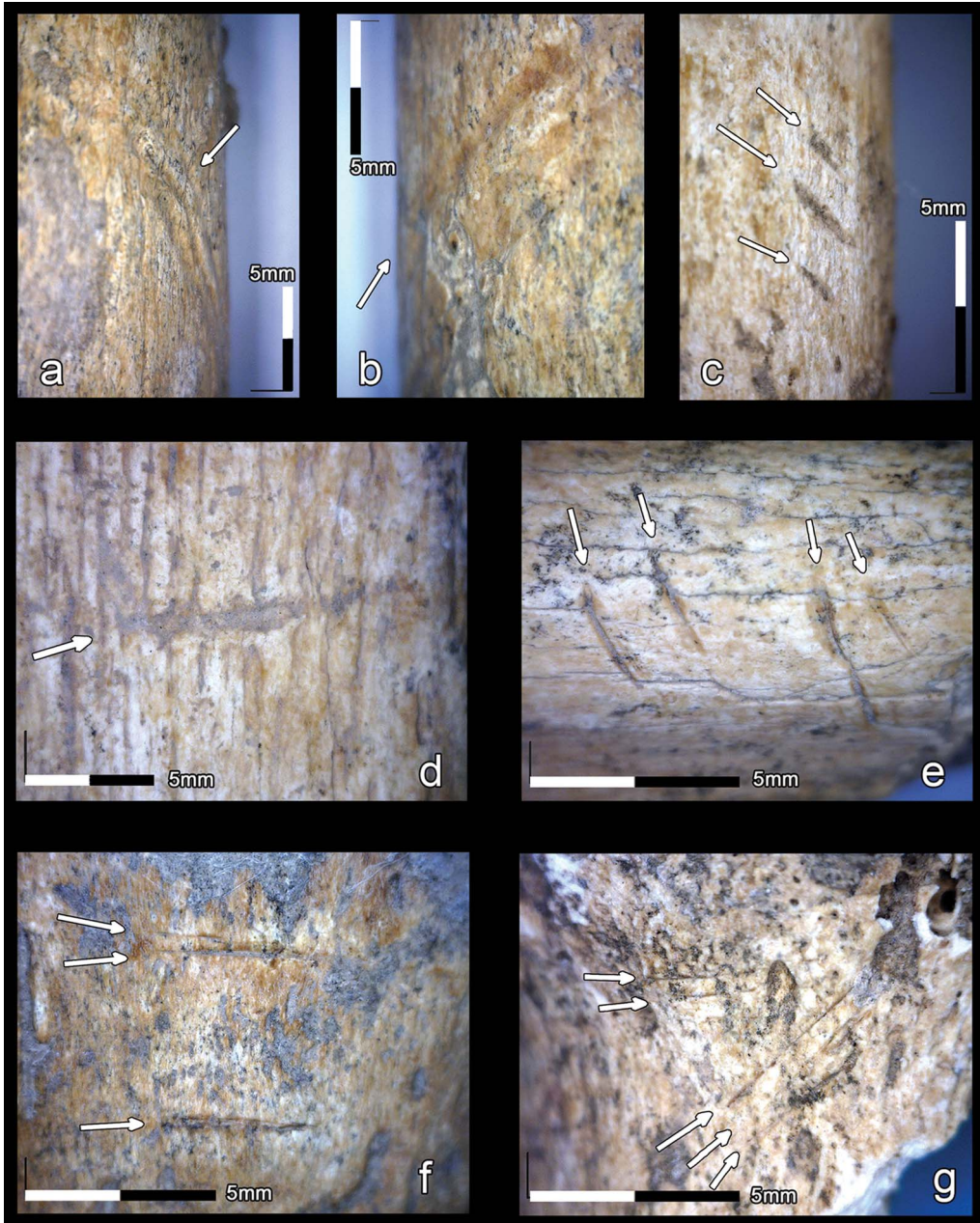


Figure 3. Types of cutmarks at Dingsishan: a & b) scraping mark on the shaft of humerus of M41-2 and femur of M108; c) chopping marks on the right femur of M273; d) slicing mark on the right tibial shaft of M270; e) parallel-line slicing mark on the left clavicle of M55; f) parallel-line slicing mark on the right patella of M55; g) clustered-line slicing mark on the left radius of M213 (figure by Z.Q. Ye & F.J. Li).

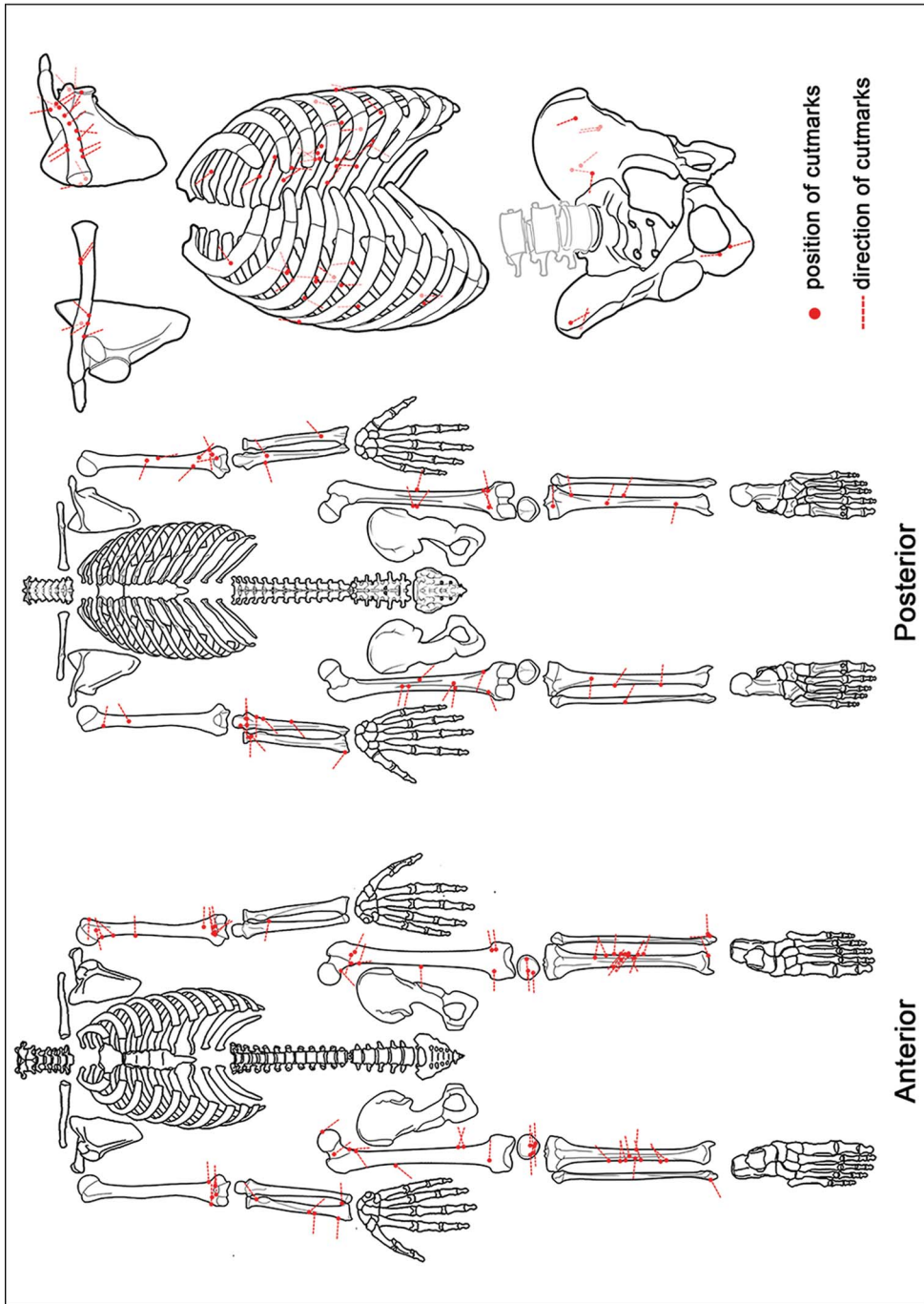


Figure 4. The distribution and directionality of cutmarks on the Dingsishan human skeletons (figure by Z. Q. Ye & F. J. Li).

Table 3. The cutmark distribution of different skeletal regions.

Skeletal region	Numbers	Individuals	Density of cutmarks
Neck disarticulation	8	6	1.33
Clavicle (m. sternocleidomastoid, trapezius)	7	5	1.40
The first rib	1	1	1.00
Shoulder disarticulation	21	14	1.50
Clavicle (m. pectoralis major, deltoid, subclavius)	8	6	1.33
Scapula (glenoid, m. infraspinatus)	6	3	2.00
Rib (m. serratus anterior)	2	2	1.00
Proximal humerus	5	5	1.00
Elbow disarticulation	33	18	1.83
Distal humerus	21	14	1.50
Proximal ulna	7	4	1.75
Proximal radius	5	3	1.67
Wrist disarticulation	11	9	1.22
Distal ulna	4	2	2.00
Distal radius	5	5	1.00
Metacarpal	2	2	1.00
Hip disarticulation	24	18	1.33
The first lumbar vertebra	2	1	2.00
Iliac ala	7	6	1.17
Ischium	2	2	1.00
Proximal femur	13	10	1.30
Knee disarticulation	32	14	2.29
Central and distal femur	21	9	2.33
Patella	10	3	3.33
Proximal tibia	1	1	1.00
Ankle disarticulation	14	9	1.56
Distal tibia	1	1	1.00
Distal fibula	3	2	1.50
Astragalus	7	4	1.75
Calcaneus	1	1	1.00
Metatarsal	2	2	1.00
Excarnation	33	21	1.57
Central tibia	30	20	1.42
Central fibula	3	1	3.00
Evisceration	36	12	3.00
Thoracic cavity	34	11	3.09
Thoracic vertebra	2	1	2.00
Total	212	57	3.72

Note: the density of cutmarks is equal to the number of cutmarks divided by the number of manipulated individuals.

Vertebrae (n = 4). Though severance of the body through the waist may be observed from the depositional arrangement of some skeletons (e.g. M107 & M191 in [Figure 2](#)), only four slicing marks are identified on the vertebrae of two individuals (M38 & M264).

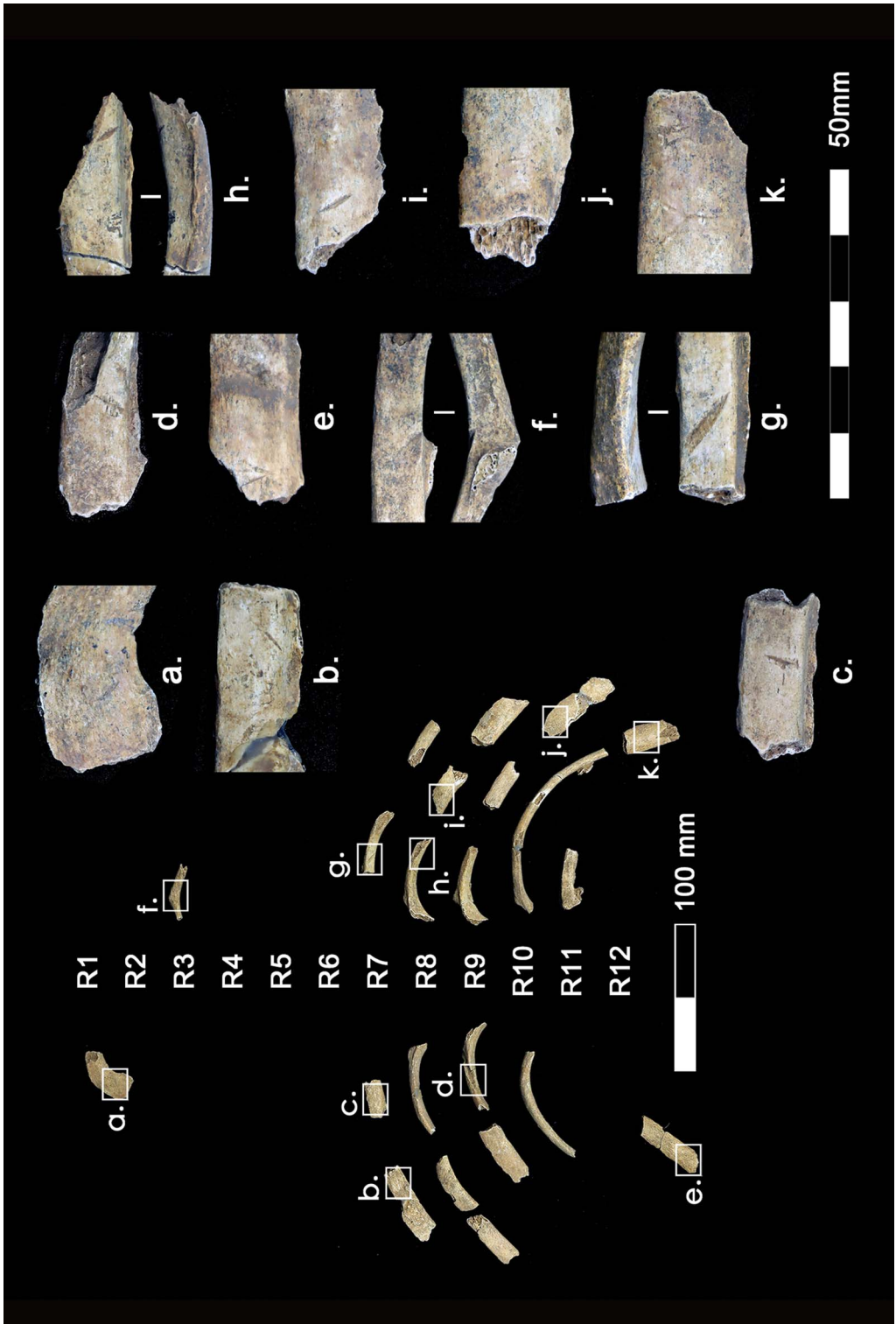


Figure 5. Cutmarks on the internal surface of the ribs of M38 (figure by Z.Q. Ye & F.J. Li).

Upper limbs:

Clavicles (n = 15). In total, 11 clavicles show slicing marks (Figure 6). Generally, these occur as parallel or clustered lines in two areas: around the origin of the sternocleidomastoid muscle or the insertion of the trapezius muscle—both of which are involved in the rotation and flexion of the head—and at the attachment of the pectoralis major, deltoid and subclavius muscles, which facilitate movement of the upper arm.

Scapulae (n = 6). Cutmarks are located around the glenoid cavity and at the attachment of the infraspinatus muscle (one on M41-1, two on M92 and three on M235, Table S1).

Humeri (n = 26). Five cutmarks are identified on the proximal part of the humerus of 15 individuals, located around the attachment site of the shoulder capsule ligament and the coracobrachialis, subscapular, deltoid and infraspinatus muscles. Twenty-one marks on 15 individuals are distributed over the humeral shaft and around the elbow.

Ulnae and radii (n = 21). Towards the elbow, cutmarks are identified at the attachment of muscles linking the upper and lower arm. Towards the wrist, slicing marks are found at the attachments of muscles linking the forearm and hand.

Ten cutmarks were found on the bones of the right and left arms of M213, their distribution suggesting an intention of arm disarticulation (Figure 7). All the cutmarks are directionally orientated towards the left side of the corpse. As experimental research illustrates that cutting motions generally move toward the operators for the convenience of hand movement



Figure 6. Parallel and clustered cutmarks on the clavicles of M63 and M135 (figure by Z.Q. Ye & F.J. Li).

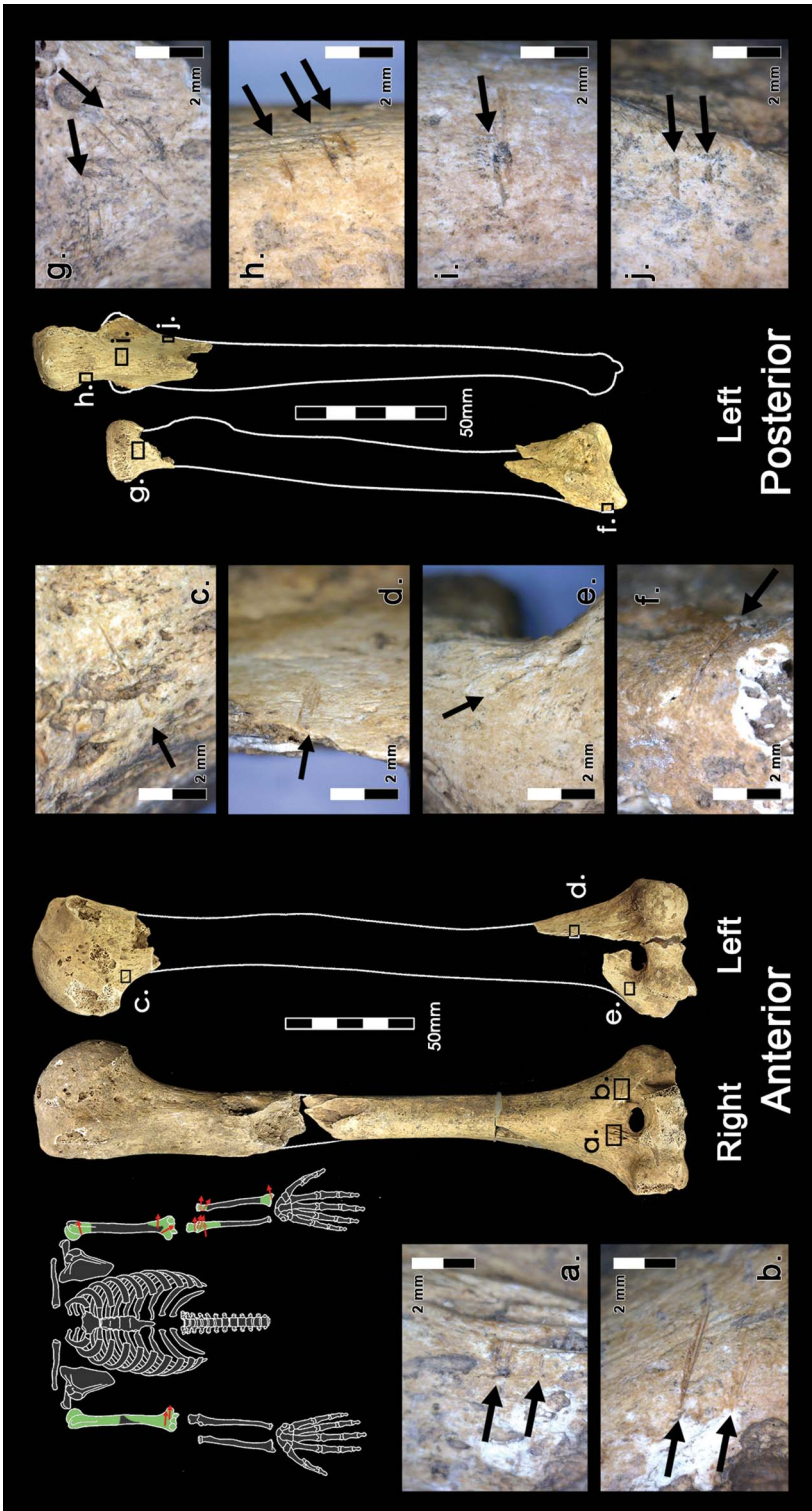


Figure 7. Cutmarks found on the upper limbs of M213 (figure by Z.Q. Ye & F.J. Li).

(Pickering & Hensley-Marschand 2008), the cutmarks on M213 suggest that the operator occupied a relatively fixed position beside the body during corpse disarticulation. An understanding of the process of disarticulation is demonstrated in the distribution of cutmarks, particularly in the focus on areas of muscular or tendinous attachment and in the more varied orientation of marks around the elbow that accommodate muscle flow and bone structure.

Lower limbs:

Pelvis (n = 9). Four cutmarks are located at the site of attachment for the iliacus muscle on the interior of the ilium. Two cutmarks to the exterior ilium may have severed the gluteus maximus, medius and minimus muscles. Three cutmarks are found on the rims of the greater sciatic notch of two individuals (Table S1).

Femora (n = 34). The femora are the second most intensive area of modification, with cutmarks concentrating around the hip and knee joints. Cutmarks on the femoral head, neck and intertrochanteric line, as well as along the medial linea aspera of the femoral shaft, suggest that soft tissue around the hip, including the iliofemoral ligament and the iliacus and adductor muscles, was severed to disarticulate the joint. Cutmarks on the distal portions of femora also indicate disarticulation of the knee by severing the muscles that crossed the joint, such as gastrocnemius, biceps femoris and vastus medialis and lateralis.

Patellae (n = 10). Concentrated on the anterior surfaces of patellae, slicing marks are oriented to suggest the removal of the quadriceps tendons and the medial and lateral retinacula.

Tibiae and fibulae (n = 38). Cutmarks are concentrated around the attachment sites of the tibialis anterior muscle and the tibiofibular ligaments (n = 24), but are also observed on the posterior (n = 7) and medial (n = 2) aspects of the tibiae and around the knee and ankle joints (n = 5). Most of the tibiofibular cutmarks do not appear to be related to disarticulation, but instead may indicate the excarnation of the muscle that controls upward and inward movement of the foot—the tibialis anterior. These cutmarks may have been made for the relaxation and adjustment of foot posture following rigor mortis. Cutmarks to the posterior tibia can only be made in the absence of intact muscles, thus natural decomposition or anthropogenic excarnation probably preceded further treatment in this area of the body.

Discussion

Deliberate and skilful manipulation

Cutmarks on skeletal remains can be considered an unintentional ‘by-product’ of mortuary preparation practices, including excarnation and disarticulation (McKinley & Smith 2017; Mazza *et al.* 2018). Analysis of the spatial distribution, frequency and directionality of cutmarks can therefore allow us to reconstruct corpse manipulation and the Neolithic body treatment process at Dingsishan. Consideration of cutmark location and the functionality of the corresponding muscular attachments (Figure 4 and Table S1) suggests that corpse treatment at Dingsishan included disarticulation (143 cutmarks at 94 joints in 47 individuals), evisceration (36 cutmarks in 11 individuals) and excarnation (33 cutmarks in 21 individuals). Disarticulation and defleshing marks were found on bones in both hyper-flexed and

contracted burials, indicating deliberate limb manipulation through disarticulation, rigor mortis relaxation and posturing.

Cutmarks are evident on just under two-thirds of the hyper-flexed individuals (61.36%) and occur at low frequency within each of these individuals. The location and frequency of cutmarks are consistent with manipulation during the early and late stages of decomposition, as demonstrated by previous micro-morphometric analyses of cut-marks on disarticulated human bones (Wallduck & Bello 2016). Given the presence of numerous slicing and chopping marks inside thoracic and abdominal cavities, it is probable that mortuary treatment was undertaken on fresh corpses at Dingsishan; similar percussive treatment in a later stage of decomposition would have resulted in distinctive fracturing of the ribs.

The orientation of cutmarks varies by functional aim and by body part (Figure 8). Defleshing (excarnation) marks show the greatest consistency in orientation; they scratch obliquely to the long axis of bones with angles around 50–75°, indicating an intention to sever the muscle fibres. Cutmarks associated with evisceration concentrate at around 80–110° and demonstrate a consistent strategy of vertical dissection along the ribs. In contrast, cutmarks associated with disarticulation show a wider range of orientations, indicating the complexity of the process and the variety of approaches.

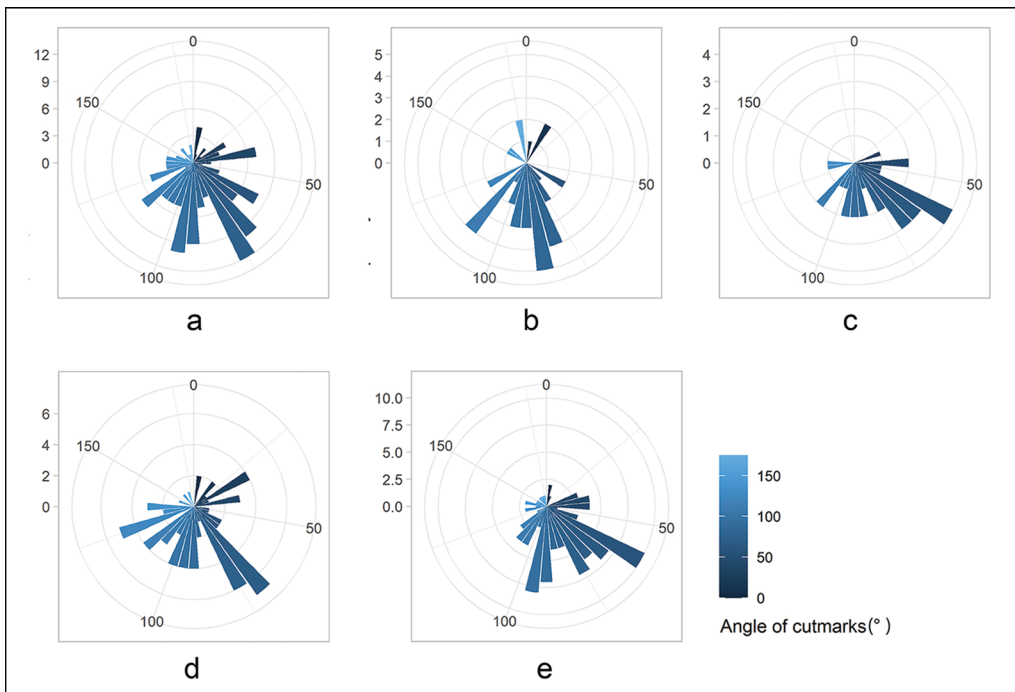


Figure 8. Rose diagrams showing orientations of cutmarks associated with different intentions and body parts: a) disarticulation; b) evisceration; c) excarnation; d & e) upper and lower limbs. The cutmarks are grouped every 5° and demonstrate a range in cutting angle from 0–180°. The number of the cutmarks is indicated by the length of the bin (diagrams created by Z.Q. Ye using ggplot2 v. 3.4.0 in R v. 4.2.2).

A variant of local Neolithic burial customs

Treatment of the corpse in the peri-mortem or post-mortem period in different cultures stimulates substantial discussion (Craig *et al.* 2005; Duday *et al.* 2009; Crozier 2018; Kerner 2018), but there is no diagnostic method for linking certain modifications (e.g. cutmarks) to specific practices (Weiss-Krejci 2005, 2011). In most cases, interpretations of behaviour are developed from certain historic and cultural contexts. The microscratch data presented here provide new evidence for the reconstruction of the function of corpse manipulation at Dingsishan.

No specific evidence for cannibalism, such as gnawing marks or thermal signatures (Jamieson 1983; Kuckelman *et al.* 2002; Cáceres *et al.* 2007), is found in this collection and only 15.57 per cent of identified cutmarks can be defined as the result of defleshing. All of the burials were located in similar subterranean pits with limited accompanying furniture (e.g. natural or shaped fragments of stone, ceramics and shellfish) (Kerner 2018) and, aside from differences in the placement of the bodies within the graves, there is nothing to indicate that manipulation was used as a mark of honour or degradation, which might lead to interpretations of human sacrifice, necrophobia or other value judgements (Aufderheide 2003; Tsaliki 2008). Moreover, the observation of cutmarks on bones from both hyper-flexed and contracted burials suggests that manipulated individuals were subsequently arranged for interment.

Variation in the positioning of cutmarks on bones and of disarticulated remains within burials means that no two individuals shared a pattern of post-mortem modification, although ultimately all manipulated individuals had flexed joints and were compressed into a limited space (Kerner 2018). We interpret this as evidence that, beyond the maintenance of a limb-flexed position, each individual was processed in a different way depending on multiple factors, including body size, age at death, level of rigor mortis and manner of death. This suggests that, although there are common aspects of interment—mature adults being, for example, more frequently in receipt of overt manipulation—the processing of corpses was variable for each body. In the ‘distant transport’ hypothesis, disarticulation, excarnation of extremities and evisceration with thoracic interment of skulls may be interpreted as aspects of funerary treatment associated with packaging the corpse for transport (Qin 2010), possibly by mobile hunter-gatherers. Considering the cramped distribution of burials (Li *et al.* 2013) and the possibility of grave space organisation (Kerner 2018), these processes could also be seen as accommodations within the funerary practice to fit individuals into pre-designated burial spaces within the whole cemetery.

Conclusion

Identification of anthropogenic modifications to bodies and burial in postures beyond the normal anatomical range denote a funerary process specific to Neolithic phases III and IV at Dingsishan. No differences in burial treatment between the sexes are apparent but mature adults dominate the manipulated assemblage. The compressed form of burial and large variation in the placement and orientation of cutmarks within each skeleton points to two likely interpretations of the underlying aim of the manipulation: the ‘distant transport’ hypothesis (Qin 2010) and the ‘space organisation’ hypothesis (Kerner 2018). Lack of consistency in the positioning of disarticulated remains and in burial postures fits the profile of unstandardised and non-ritualistic behaviour.

Yet the deliberate and accurate cutmarks on skeletons imply several sequential and highly organised mortuary processes. Considerable effort was placed on the preparation, management and implementation of corpse treatment, and these goal-oriented and strategic manipulations would require a measure of co-operation, experience and even technical knowledge. Thus, this process could be interpreted as a respectful mourning and/or an attempt at consistency with the wider limb-flexed burial custom.

This study provides new information on post-mortem processing of human remains in Neolithic southern China and opens the possibility of further comparisons with similar deposits from other geographic areas. Furthermore, given the intimate interaction between Neolithic cultures in Southeast Asia, application of the combined microscratch and archaeo-anatomical method employed here at other sites within the region may shed light on the origins and influences of Neolithic funerary practices more generally.

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Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.15184/aqy.2024.57>.

References

- AUFDERHEIDE, A.C. 2003. *The scientific study of mummies*. Cambridge: Cambridge University Press.
- BOZ, B. & L.D. HAGER. 2014. Making sense of social behavior from disturbed and commingled skeletons: a case study from Çatalhöyük, Turkey, in A. Osterholtz, K. Baustian & D. Martin (ed.) *Commingled and disarticulated human remains: working toward improved theory, method, and data*: 17–33. New York: Springer. https://doi.org/10.1007/978-1-4614-7560-6_2
- BRONK RAMSEY, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 337–60. <https://doi.org/10.1017/S0033822200033865>
- BRUZEK, J. 2002. A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology* 117: 157–68. <https://doi.org/10.1002/ajpa.10012>
- CÁCERES, I., M. LOZANO & P. SALADIÉ. 2007. Evidence for Bronze Age cannibalism in El Mirador cave (Sierra de Atapuerca, Burgos,

- Spain). *American Journal of Physical Anthropology* 133: 899–917.
<https://doi.org/10.1002/ajpa.20610>
- CHEN, WEIJU. 2016. Research on Neolithic chronologies and subsistence strategies of the Lingnan area. Unpublished PhD dissertation, Jilin University (in Chinese).
- CRAIG, R., C.J. KNÜSEL & G.C. CARR. 2005. Fragmentation, mutilation and dismemberment: an interpretation of human remains on Iron Age sites, in M.P. Pearson & I.J.N. Thorpe (ed.) *Warfare, violence and slavery in prehistory* (British Archaeological Reports International Series 1374): 165–80. Oxford: BAR Publishing.
- CROZIER, R. 2018. *A taphonomic approach to the reanalysis of the human remains from the Neolithic chamber tomb of Quanterness, Orkney* (British Archaeological Reports British Series 635). Oxford: BAR Publishing.
<https://doi.org/10.30861/9781407315713>
- DAUBARAS, M. 2020. Kretuonas: cut-marks on human bones and their implications for the burial traditions of Early-Middle Neolithic communities in Lithuania. *Archaeologia Baltica* 27: 8–16.
<https://doi.org/10.15181/ab.v27i0.2175>
- DUDAY, H., A.M. CIPRIANI & J. PEARCE. 2009. *The archaeology of the dead: lectures in archaeoethnatology*. Oxford: Oxbow.
<https://doi.org/10.2307/j.ctt1cd0pkv>
- FERNANDEZ-JALVO, Y. & P. ANDREWS. 2016. *Atlas of taphonomic identifications: 1001+ images of fossil and recent mammal bone modification*. New York: Springer.
<https://doi.org/10.1007/978-94-017-7432-1>
- FU, XIANGUO 2002. The Dingsishan site and the prehistory of Guangxi, South China. *Bulletin of the Indo-Pacific Prehistory Association* 22: 63–72.
- Guangxi Team *et al.* 1998. Excavation of Dingsishan site, Yongning, Guangxi province. *Kaogu (Archaeology)* 11: 11–33 (in Chinese).
- HE, ANYI, QINGPING YANG & YONGQIN NING. 2009. New archaeological discovery and preliminary understanding of shell midden sites in the Zuojiang River Basin in Guangxi. *Chinese Historical Relics* 5: 4–11 (in Chinese).
- JAMIESON, J.B. 1983. An examination of prisoner-sacrifice and cannibalism at the St. Lawrence Iroquoian Roebuck site. *Canadian Journal of Archaeology/Journal Canadien d'Archéologie* 7: 159–75.
- KERNER, J. 2018. *Manipulations post-mortem du corps humain: implications archéologiques et anthropologiques*. Lieden: Sidestone.
- KANJOU, Y., I. KUIJT, Y.S. ERDAL & O. KONDO. 2015. Early human decapitation, 11,700–10,700 cal bp, within the pre-pottery Neolithic village of Tell Qaramel, North Syria. *International Journal of Osteoarchaeology* 25: 743–52.
<https://doi.org/10.1002/oa.2341>
- KNÜSEL, C.J. 2014. Crouching in fear: terms of engagement for funerary remains. *Journal of Social Archaeology* 14: 26–58.
<https://doi.org/10.1177/1469605313518869>
- KUCKELMAN, K.A., R.R. LIGHTFOOT & D.L. MARTIN. 2002. The bioarchaeology and taphonomy of violence at Castle Rock and Sand Canyon Pueblos, southwestern Colorado. *American Antiquity* 67: 486–513.
<https://doi.org/10.2307/1593823>
- LI, FA-JUN, MING-HUI WANG, XIAN-GUO FU, KEITH DOBNEY, ZHEN LI, BO-YU CHEN & CHONG YU. 2013. Dismembered neolithic burials at the Ding Si Shan site in Guangxi, Southern China. *Antiquity* 87. Available at: <http://antiquity.ac.uk/projgall/fu337/> (accessed 14 February 2023).
- LORKIEWICZ, W. 2011. Unusual burial from an early Neolithic site of the Lengyel culture in central Poland: punishment, violence or mortuary behaviour? *International Journal of Osteoarchaeology* 21: 428–34.
<https://doi.org/10.1002/oa.1149>
- LOVEJOY, C.O. 1985. Dental wear in the Libben population: its functional pattern and role in the determination of adult skeletal age at death. *American Journal of Physical Anthropology* 68: 47–56.
<https://doi.org/10.1002/ajpa.1330680105>
- MARIOTTI, V., I.M. MUNTONI & M.G. BELCASTRO. 2020. New insights into the funerary rituals of the neolithic site of Passo di Corvo (Apulia, Italy): the study of the human remains. *Journal of Archaeological Science: Reports* 34: 102643.
<https://doi.org/10.1016/j.jasrep.2020.102643>
- MARIOTTI, V., M.G. BELCASTRO & S. CONDEMI. 2016. From corpse to bones: funerary rituals of the Taforalt Iberomaurusian population. *Bulletins et Memoires de la Societe d'Anthropologie de Paris* 28: 60–65.
<https://doi.org/10.1007/s13219-016-0150-4>

- MATSUMURA, HIROFUMI, HSIAO-CHUN HUNG, LI ZHEN & KENICHI SHINODA (ed.) 2017. *Bio-anthropological studies of Early Holocene hunter-gatherer sites at Huiyaotian and Liyupo in Guangxi, China* (National Museum of Nature and Science Monographs 47). Tokyo: National Museum of Nature and Science.
- MAZZA, B., A. ACOSTA, A. GUARIDO, N. BUC & D. LOPONTE. 2018. Anthropogenic modifications to archaeological human bones from the lower Paraná River basin (Argentina). *Journal of Archaeological Science: Reports* 20: 647–61. <https://doi.org/10.1016/j.jasrep.2018.06.013>
- McKINLEY, J.I. & M. SMITH. 2017. Compiling a skeletal inventory: disarticulated and co-mingled remains, in P.D. Mitchell & M. Brickley (ed.) *Updated guidelines to the standards for recording human remains*: 20. Cambridge: Institute of Field Archaeologists.
- PAN, S.X. 2004. The explanation of ‘Yi di’ in historical books and the interpretation of dismembered burial at Dingsishan Site. *Guangxi Ethnic Studies* 4: 121–23 (in Chinese).
- PICKERING, T.R. & B. HENSLEY-MARSHAND. 2008. Cutmarks and hominid handedness. *Journal of Archaeological Science* 35: 310–15. <https://doi.org/10.1016/j.jas.2007.03.012>
- POTTS, R. & P. SHIPMAN. 1981. Cutmarks made by stone tools on bones from Olduvai Gorge, Tanzania. *Nature* 291: 577–80. <https://doi.org/10.1038/291577a0>
- QIN, FANG. 2010. Study on the prehistoric limb-bending burial and dismembered burial at the Dingsishan site, Yongning, Guangxi province. *Cultural Relics in Southern China* 2: 74–80 (in Chinese).
- 2015. Lingwu, the ruins of shell mounds in Nanning, Guangxi, in W. Wang (ed.) *Chinese Archaeological Yearbook*: 275. Beijing: China Social Sciences Press (in Chinese).
- REILLY, S. 2003. Processing the dead in Neolithic Orkney. *Oxford Journal of Archaeology* 22: 133–54. <https://doi.org/10.1111/1468-0092.t01-1-00002>
- REIMER, P.J. et al. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 kcal BP). *Radiocarbon* 62: 725–57. <https://doi.org/10.1017/RDC.2020.41>
- ROBB, J., E. ELSTER, E. ISETTI, C.J. KNÜSEL, M.A. TAFURI & A. TRAVERSO. 2015. Cleaning the dead: Neolithic ritual processing of human bone at Scaloria Cave, Italy. *Antiquity* 89: 39–54. <https://doi.org/10.15184/aqy.2014.35>
- SHIPMAN, P. 1981. Applications of scanning electron microscopy to taphonomic problems. *Annals of the New York Academy of Sciences USA* 376(1): 357–85. <https://doi.org/10.1111/j.1749-6632.1981.tb28179.x>
- SMITH, M.J. & M.B. BRICKLEY. 2004. Analysis and interpretation of flint toolmarks found on bones from West Tump long barrow, Gloucestershire. *International Journal of Osteoarchaeology* 14: 18–33. <https://doi.org/10.1002/oa.710>
- TOUSSAINT, M. 2011. Intentional cutmarks on an early Mesolithic human calvaria from Margaux Cave (Dinant, Belgium). *American Journal of Physical Anthropology* 144: 100–7. <https://doi.org/10.1002/ajpa.21375>
- TRINH, HIEP HOANG & DAMIEN HUFFER. 2015. The Đa Bút period in Northern Vietnam: current knowledge and future directions. *Journal of Indo-Pacific Archaeology* 35: 36–47. <https://doi.org/10.7152/jipa.v35i0.14894>
- TSALIKI, A. 2008. Unusual burials and necrophobia: an insight into the burial archaeology of fear, in E.M. Murphy (ed.) *Deviant burial in the archaeological record*: 1–16. Oxford: Oxbow.
- VIET, NGUYEN. 2005. The Đa Bút Culture: evidence for cultural development in Vietnam during the middle Holocene. *Bulletin of the Indo-Pacific Prehistory Association* 25: 89–94.
- WALLDUCK, R. & S.M. BELLO. 2016. Cutting decaying bodies: micro-morphometric analysis of cut-marks on Mesolithic-Neolithic human remains from Lepenski Vir and Vlasac, Serbia. *Journal of Archaeological Science: Reports* 10: 703–14. <https://doi.org/10.1016/j.jasrep.2016.06.036>
- WEISS-KREJCI, E. 2005. Excarnation, evisceration, and exhumation in medieval and post-medieval Europe, in G.F. Rakita, J.E. Buikstra, L.A. Beck & S.R. Williams (ed.) *Interacting with the dead: perspectives on mortuary archaeology for the new millennium*: 155–72. Gainesville: University Press of Florida.
- 2011. The formation of mortuary deposits: implications for understanding mortuary behavior of past populations, in S.C. Agarwal & B.A. Glencross (ed.) *Social bioarchaeology*:

Neolithic mortuary practices at Dingsishan

- 68–106. Chichester: Wiley-Blackwell.
<https://doi.org/10.1002/9781444390537.ch4>
- ZHANG, CHI & HSIAO-CHUN HUNG. 2012. Later hunter-gatherers in southern China, 18 000–3000 BC. *Antiquity* 86: 11–29.
<https://doi.org/10.1017/S0003598X00062438>
- ZHAO, ZHIJUN, LIEDAN LU & XIANGUO FU. 2005. Analysis and study of phytoliths excavated from Dingsishan site in Yongning County of Guangxi, China. *Kaogu (Archaeology)* 11: 76–84 (in Chinese).
- ZHU, SIMEI, FAJUN LI, XIANGLONG CHEN, XIANGUO FU & YAOWU HU. 2021. Subsistence and health in Middle Neolithic (9000–7000 BP) southern China: new evidence from the Dingsishan site. *Antiquity* 95: 13–26.
<https://doi.org/10.15184/aqy.2020.214>