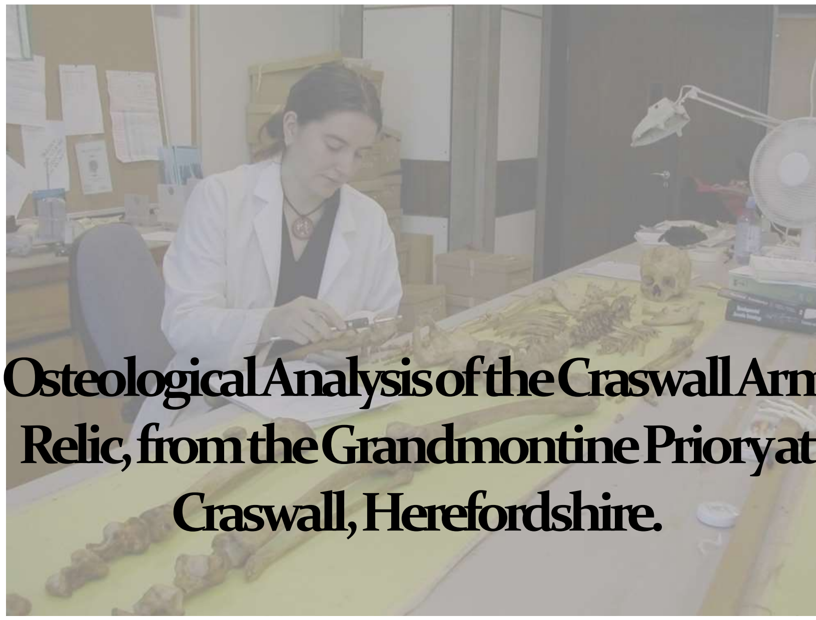

Osteological Analysis of the Craswall Arm Relic, from the Grandmontine Priory at Craswall, Herefordshire.

A Report for the CraswallGrandmontine Society

November 2021

Project OA1070

1. Introduction

The aim of this report is to present the dataresulting from the osteological analysis of the Craswall arm relic, excavated from the site of the Grandmontine Priory at Craswall, Herefordshire by C. J. Lilwall in 1904. The relic, consisting of a forearm,was discovered in'a leaden box … containing the bones of the left forearm and hand, probablythe relic of some canonised person'.(*Transactions*of the Woolhope Naturalists Field Club 1904. pp.346-7). In 1942, George Marshall gave a lecture to the WoolhopeNaturalists Field Club about the arm, stating that he believed it to represent the bones of the martyred Saint Ursula and 11,000 virgins of Cologne, dating to between 300-600AD (*TWNFC* 1942, pp. 18-21; Johnson 2023).

In 1966, the bones were subsequently analysed by the osteologist I. W. Cornwall, based at University College London. Cornwall prepared a full report in which he described the forearm as having been severed from the upper arm at the elbow joint by means of several blows to the joint while the arm was still 'fresh', 'perhaps using an axe or a meat-cleaver' (Cornwall 1966, p.252). He also concluded that this individual was more likely to have been male than female based on his estimation of stature from measurement of the radius as well as from the large, robust nature of the bones (Cornwall1966, p.253).

Over the years since its discovery, the Craswall arm relic has continued to be a source of fascination, prompting re-evaluation to further understand its origin and significance. Since the osteological analysis in 1966, osteological methods and scientific methods have evolved considerably, and in recognition of this the CraswallGrandmontine Society commissioned a new analysis and conservation of the human forearm, using the latest techniques to garner further scientific information about this unique find. The analysis undertaken forms the basis of the report presented here.

2. The Human Bone

2.1 Reasons for the Analysis

Osteological analysis was carried out to ascertain:

- Inventory of the skeletal material

- Condition of bone present
- Completeness of the elements present
- Age Assessment
- Sex Determination
- Non-metric Traits
- Stature and Morphometric Data
- Skeletal Pathology
- Radiographic Analysis
- aDNA Analysis
- Radiocarbon Dating
- Stable Isotopic Analysis

2.2 *Methods and Process*

The skeletal material was analysed according to the standards laid out in the guidelines recommended by the British Association of Biological Anthropologists and Osteologists in conjunction with the IFA (Guidelines to the Standards for Recording Human Remains, Brickley and McKinley (eds) 2004, updated 2018) as well as by English Heritage (Human Bones from Archaeological Sites: Guidelines for producing assessment documents and analytical reports, Centre for Archaeology Guidelines, 2002).

Recording of the material was carried out using the recognised descriptions contained in Standards for Data Collection from Human Skeletal Remains by Buikstra and Ubelaker (1994).

Full recording forms are supplied separately to be archived with any other archaeological recording forms. All skeletal data has been recorded using an MS-Access database(s).

The material was analysed macroscopically and where necessary with the aid of a magnifying glass for identification purposes. Where relevant, digital photographs have been used for illustration and a full digital image archive of all pathologies and any other features of interest has been provided.

The material was analysed without prior knowledge of associated artefacts so that the assessment remained as objective as possible.

Comparison of the results was made with published osteological data from contemporary skeletal populations where relevant.

2.3 Skeletal Inventory

An inventory of the skeletal elements present is undertaken to quantify the size of the assemblage and the number of individuals present. As the inventory also provides information abouteach individual element, assessment can also be made as regards to the presence and frequency of pathological changes.

All identifiable fragments, with the exception of those lacking any diagnostic morphological features, were recorded to provide a catalogue of the individual skeletal elements recovered.

The long bones are recorded according to the presence or absence of the proximal (upper), middle and distal (lower) sections as well as the proximal and distal joint surfaces. Superior/proximal and inferior/distal joint surfaces are also recorded as 'observable' or 'unobservable' for other elements where possible, such as the vertebral bodies.

The arm consisted of the following left sided elements:

- Bones of the forearm and elbow joint: Capitulum of the humerus, ulna, radius.
- Wrist bones: Scaphoid, lunate, triquetral, trapezium, trapezoid, capitate and hamate (pisiform absent)

- Bones of the hand: 1st, 2nd, 3rd, 4th and 5th metacarpals, all proximal and middle hand phalanges, distal hand phalanges of the 1st, 2nd and 3rd digits.

Thus the skeletal elementsrepresent a left forearm that is almost complete (Figures 1 and 2).

Figure 1:*Anterior View of the Craswall Arm Relic*

Figure 2:*Posterior View of the Craswall Arm Relic*

2.4 Condition of the Bone Present

The condition of the bone was assessed macroscopically according to the categories and descriptions provided by the Guidelines to the Standards for Recording Human Remains (Brickley and McKinley, eds, 2004). Since most skeletons exhibit more than one grade of state of preservation, these categories are simplified into 4 main groups of preservation: Good (grades 0-2), Fair (grades 2-4), Poor (grades 4-5+) and Varied (more than 4 grades of condition). The condition of human bone can be influenced by both extrinsic (i.e.taphonomic conditions) and intrinsic (i.e. robustness) factors (Henderson 1987).

The skeletal elements were of ‘good’ condition, being grade 0-1. It was noted that the elements were very fragile, however.

2.5 Completeness of Elements

Each bone element wasassessed for completeness according to the following categories: <25%, 25-50%, 50-75% and 75%>.Recording the completeness of elements can allow an insight to be gained into activity regarding the deposition of the human remains that has occurred as well as an assessment of how much information can potentially be gained from the remains.

All the elements were over 75% complete with the exception of the capitulum of the humerus, which obviously only represented a very small fragment of the humerus. Some minor damage had occurred to some of the ends of the bone high in the more fragile cancellous bone but this was largely insignificant and taphonomic in origin.

2.7 Age Assessment

Establishing the age and sex of individuals from an archaeological assemblage not only provides an insight into the demographic profile of the population but can also be used to inform us of patterns in pathological distributions in a skeletal assemblage.

The age of sub-adults is assessed using both dental development (Smith 1991) and eruption (Ubelaker 1989) as well as long bone lengths (Schaefer *et al*. 2009) and epiphyseal fusion (Scheuer & Black 2004). These methods can usually provide a reasonably accurate age estimation due to a relatively narrow range of variation in normal sub-adult development. Thus, sub-adults can be placed into the following age categories: Foetal (<36 weeks), Neonate (0-1 month), Young Infant (1-6 months), Older Infant (6-12 months), Child (1-5 years), Juvenile (6-12 years) and Adolescent (13-17 years).

Assessment of adult age at death, unfortunately, results in much less specific age estimates due to a much greater individual variation in the features exhibited by the examined elements at particular ages (Cox 2000). Age estimation of adults was assessed from analysis of the auricular surface (Lovejoy et al 1985) and the pubic symphysis (Brooks and Suchey, 1990). Each of these methods examines the deterioration of these surfaces and categorises them accordingly. This deterioration is due in part to the health status of the individual but can also be influenced by life-style and so the variation produced by these factors results in much wider age categories: Very Young Adult (18-24), Young Adult (25-34), Middle Adult (35-49) and Old Adult (50+) (Buikstra and Ubelaker, 1984). Dental attrition can also be used as an indicator of age, where a general wearing down of the occlusal surfaces of the teeth can be observed with increasing age (Miles 1963).

Due to the limited nature of the skeletal elements present in the forearm, age could only be assessed based on observations of the skeletal development of the long bones. The epiphyses present were all fully fused and therefore the individual represented an adult individual.

2.8 Sex Determination

Sex is assessed using the criteria laid out by Buikstra and Ubelaker (1984) in the analysis of morphological features of the skull and pelvis. In addition, metric data is also used where possible, taking measurements of sexually dimorphic elements such as the femoral and humeral head (Bass 1995). Categories ascribed to individuals on the basis of this data were 'Male', 'Possible Male', 'Indeterminate', 'Possible Female', 'Female' and 'Unobservable'. Sex may be ascribed on the basis of metrics alone where no sexually dimorphic traits are observable. Where sex was not observable by either metric or morphological observations, it was recorded as 'Unobservable'. No sexing of sub-adult material is attempted due to the lack of reliable criteria available.

The biological sex of this individual could not be assessed using the standard osteological methods due to only the bones of the forearm being present.

2.10 Non-Metric Traits

Non-metric traits are morphological features that occur both in bone and dentition. These features have no specific functional purpose and occur in some individuals and not in others. The origins of non-metric traits have now been shown to be highly complex, each having its own aetiology and each being influenced to differing extents by genetics, the environment and by physical activity. A review of the current literature suggests that the undetermined specific origins of these traits and the fact that there is more genetic variation within populations than between them can prevent useful conclusions regarding their presence or absence in skeletal remains from being drawn (Tyrell 2000).

No non-metric traits were observed in these skeletal elements.

2.11 Stature and Morphometric Analysis

Stature of adult individuals can be reconstructed from measurements of long bones of the skeleton. Since the long bones of sub-adults have not yet fully developed it is not possible to provide an estimate of stature for immature remains. Stature is the result of many factors including genetics and environmental influences (Floud*et al*. 1990), such as malnutrition and poor health. Height can be used as an indicator of health status and there is a wide range of literature on the relationships between height, health and social status. Estimated stature was calculated by taking the measurements of the individual long bones and using the formula provided by Trotter (1970). Variation in estimated stature can be up to 3cm.

It should be noted that stature estimations based on arm bones are not as accurate as those based on leg bones.

Stature was estimated from the radius, which measured 243mm in length. Stature is estimated to be 1.70m based on estimations for females or 1.71m based on estimations for males. Average medieval stature for females at this time is reported as 1.59 for females and 1.71 for males (Roberts and Cox 2003).

2.12 Perimortem Modifications

Perimortem modifications can be defined as modifications made to the body through artificial interventions, as exhibited by the skeletal remains in the form of cut marks, saw marks or chop marks, at or around the time of death (Rainwater 2015, Reichs 1998).For example, this can include surgical intervention, in the form of amputation or post-mortem examination, or in the context of execution and funerary rites, decapitationor defleshing. There is no conclusive way to establish if cuts to the bone represent a cause of death in archaeological human skeletal remains.

The characteristics typical of perimortem intervention are a result of modifications being made to ‘wet’ bone i.e. bone that retains a certain level of collagen. Perimortem cut surfaces tend to be smooth with sharp, linear edges and the affected bone retains the same colouration. Once bone becomes ‘dry’, sometime after death, marks made by interventions or accidental fracturing take on different characteristics; the surface of the bone tends to appears stepped or roughened, edges may be more rounded and colouration of the surface is often much lighter and markedly different to the surrounding bone. Cut marks and saw marks may also leave traces of the use of blades across the surface in the form of parallel striae or sharp incisive type cuts.

The capitulumof the humerus (now artificially attached to the head of the radius)and the ulna in the Craswall arm relic have clearly been severed perimortem; the presence of the severed capitulum is testament to the presence of soft tissues holding this fragment *in situ* at the time of deposition in the ground. The cut is angulated through the proximal part of the ulna (olecranon process) which forms the elbow joint, running superoinferiorly from posterior to anterior. The trabeculae across the severed surface are a uniform colour, the edges of the bone are sharp and,over the mid third of the severed surface of the ulna,there is a plane of bone that is smooth and flat, with a linear profile in lateral view (Figures 3 and 4). Breakaway notches are present on the lateral side of this cut plane of bone. These represent hollows in the bone that are formed when a part of the bone is detached through breakage rather than being cut directly. A portion of the olecranon process has also been fractured on the medial side of the cut plane of bone, which remains *in situ.* A small fragment of bone is missing from the tip of the coronoid process of the ulna on the anterior side of the joint; it is difficult to assess if this has occurred as part of the cut that severed the forearm but this is a possibility. The surface of the capitulum is roughened and slightly conical in profile, with some damage to the lateral side.

As part of this severance, a small portion of the very distal part of the humerus, formed by the distal most portion of the capitulum, has been transected and remained *in situ* due to the presence of soft tissues at the time. There is some limitation to interpreting the alignments of the cut(s) since the current reconstruction of the capitulum as articulated with the radial head is missing the original soft tissues and is not in the correct anatomical position;*in vivo*, the radial head and capitulum are covered with articular cartilages that maintain the radiocapitellar gap between the two. Additionally, it also must be taken into account that the elbow is a hinge joint and the olecranon process of the ulna moves during flexion in relation to the humerus. It is also not possible to assess any evidence for defleshing and cuts that the absent humerus might have exhibited. Overall, however, the transection of the capitulum does not appear to have occurred in the same plane as the ulna if the arm was in the correct anatomical position at the time it was severed (i.e. held straight down the side of the body). In this position, the capitulum has been severed in the transverse plane, while the cut across the ulna is oblique. However, if the arm was flexed at 90 degrees or more at the time the arm was severed, this would expose the olecranon of the ulna and the capitulum of the humeruson an alignment that a cut could be made through to sever the joint; a cut on this alignment could also explain the damage to the tip of the coronoid process of the ulna.

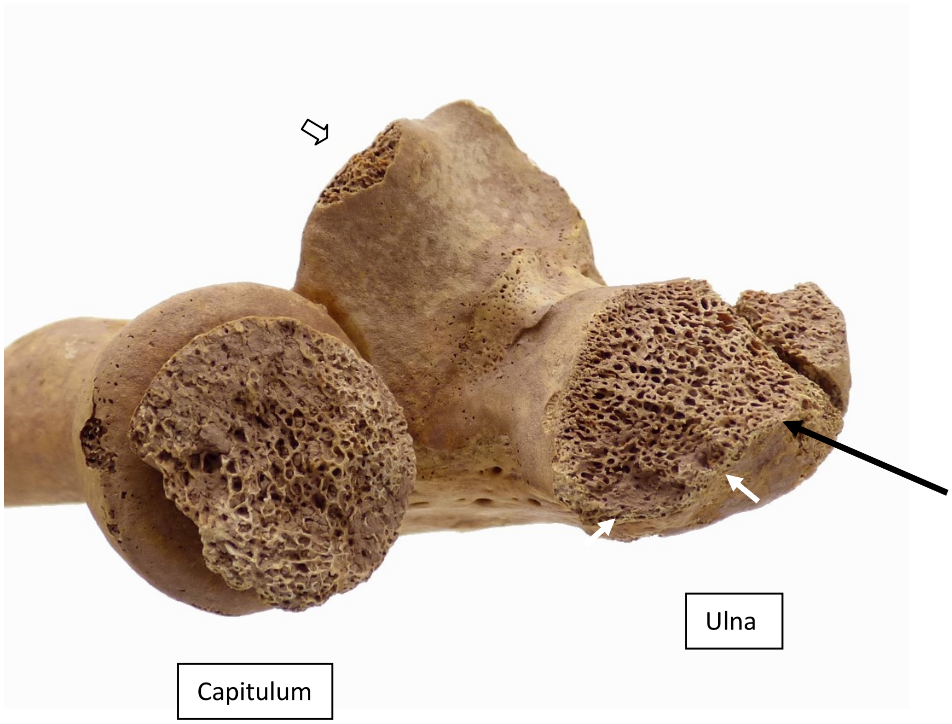

Figure 3:*Superior View of the Severed Surfaces of the Capitulum (left) and Ulna (right). The flat smooth portion of surface is arrowed in black. Break away notches arrowed in solid white. The fractured fragment of olecranon process of the ulna can be seen far right and damage to the tip of the coronoid process arrowed (white with black outline).*

Figure 4:*Lateral view of the radius and ulna illustrating the sharp, flat plane of the cut (arrowed).*

Consideration of the anatomy of the elbow joint aids an understanding of the technique that might have been used to sever the forearm. Figure 5 below illustrates the basic anatomy of the elbow joint when flexed. The olecranon process is the bony prominence that can be easily felt on the back of the elbow joint, and is covered by comparatively little soft tissue.After reflecting the covering skin, transecting the ulna along the plane used in the Craswall arm avoids the oblique and upper band of the ulnar collateral ligament as well as the attachment sites of the triceps tendon and the anconeus muscles. A cut along this plane offers a relatively simple way to release the ulna from the articulating humerus.

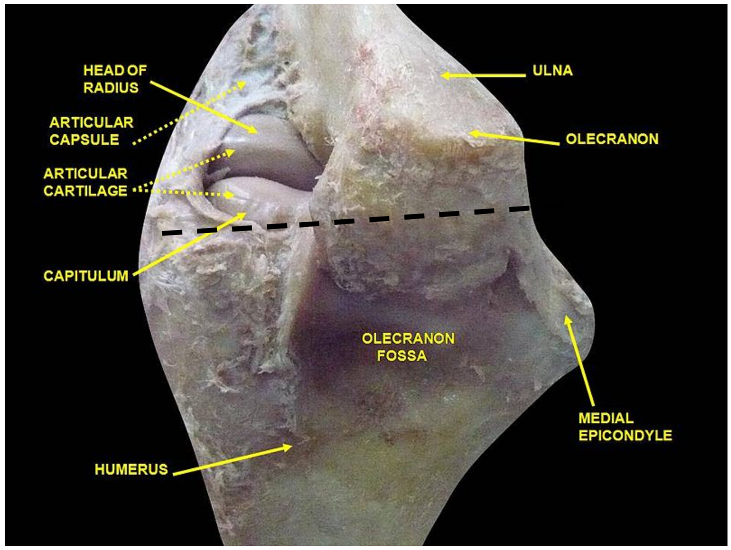

Figure 5:*Anatomy of the elbow joint in flexed position from the posterior side, with dashed lines indicating the line of transection of the joint in the Craswall arm.(https://upload.wikimedia.org/wikipedia/commons/2/25/Slide3bgbg.JPGCCASA 3.0, Anatomist90).*

With the forearm largely free of the upper arm following this step, it would then only remain for the radius to be detached from the humerus on the lateral side. The capitulum forms a rounded joint on the anterior aspect of the humerus and articulates with the radius head. Once the extensor muscles were reflected, cutting through the tip of the capitulum in approximate line with the cut already made through the ulna would avoid the annular ligament and musculature located at the proximal radius.

In respect of this observation, the forearm could have been severed from the posterior side, where the precise anatomical location and angulation of the ulna could have been readily identified. A clean cut through the ulna using a relatively narrow but sharp blade like a chisel might explain the smooth cut plane of bone across the middle third of olecranon, with breakage to either side. The roughened surface of the capitulum with a conical peak of bone in the centre could possibly indicate that a knife was used to cut around the capitulumfrom two or more aspects, likely posterior and anterior, to free it from the joint.Additionally, the irregular edge to the lateral aspect of the capitulum where some of the periphery of the capitulum is absent may indicate that the forearm was finally detached at this point, though it should be borne in mind that post-mortem damage may also have contributed to this fragmentation.

Severance of the arm across these anatomical structures in this way would likely have required anatomical knowledge and experience. Given the absence of evidence for multiple blows, the transection appears to have been undertaken in a careful manner. This is sometimes a pattern observed in forensic cases, for example, where dismemberment undertaken through the joints has often been undertaken by a culprit with previously acquired butchery skillsor anatomical knowledge (Reichs 1998), although other cases involving dismemberment at the joints suggest otherwise (Rainwater 2015). A heavy and broad sharp-edged implement like a cleaver may have been used to cut through the ulna as suggested by Cornwall (1966); while modern cleavers are designed as a chopping tool, medieval cleavers have a degree of curvature to the front part of the blade (Seetah 2019). This shaping allows a slicing as well as chopping function, making for more refined intervention. It also is a possibility, however, that smallertools such as a chiseland large knife could have produced the patterns of cuts and breakage. Reichs (1998) and Rainwater (2015) observe that often more than one tool is employed in the process of dismemberment.

2.13 Skeletal Pathology

Palaeopathology is the study of diseases of past peoples and can be used to infer the health status of groups of individuals within a population as well as indicate the overall success of the adaptation of a population to its surrounding environment. Pathologies are categorised according to their aetiologies; e.g. congenital, metabolic, infectious, traumatic, neoplastic etc. (Roberts and Manchester 1997). Any pathological modifications to the bone are described. The size and location of any lesion is also noted.

An insight into the nature of skeletal disease present in a population can be gained through examination of the prevalence rates of each type of disease. However, any prevalence rates calculated for this assemblage will be skewed by the small number of skeletal elements present. Here, the pathological observations will be presented as a catalogue for comparison and integration with future studies.

The only pathological changes noted to the Craswall Arm was a very minor amount of peripheral osteophytic lipping present around the articular fact for the pisiform wrist bone on the triquetral bone. This indicates a minor amount of degenerative joint disease at the joint that clinically is observed occurring as a primary condition in older aged adults or as secondary to trauma or repetitive strain in younger individuals to the surrounding soft ligaments and flexor carpi ulnaris tendon, most commonly seen in hand workers or volleyball players (Eyer 2022).

2.14 Radiographic Analysis

Radiographic analysis was undertaken to identify any potential pathological changes that were not observable macroscopically. No pathological lesions were observed and the bone present appeared robust and healthy (Figure 6). Some small,high density flecks were observed within the bone and these were likely to represent small fragments of lead from the casket originally containing the arm that had migrated into the bone as a post-mortem process.

The radiographs were taken prior to the conservation of the arm and the removal of artificial parts used in the reconditioning of the arm in the 1960s. The high density seen in the area of the pisiform has been caused by the use of artificial material to make a replica replacement; similarly the comparatively low density seen in the 4th metacarpal is due to this element being a plastic replica. The original has now been reinstated. The oblong black area of low density seen in the ulna diaphysis represents the sample of bone removed for radiocarbon dating.

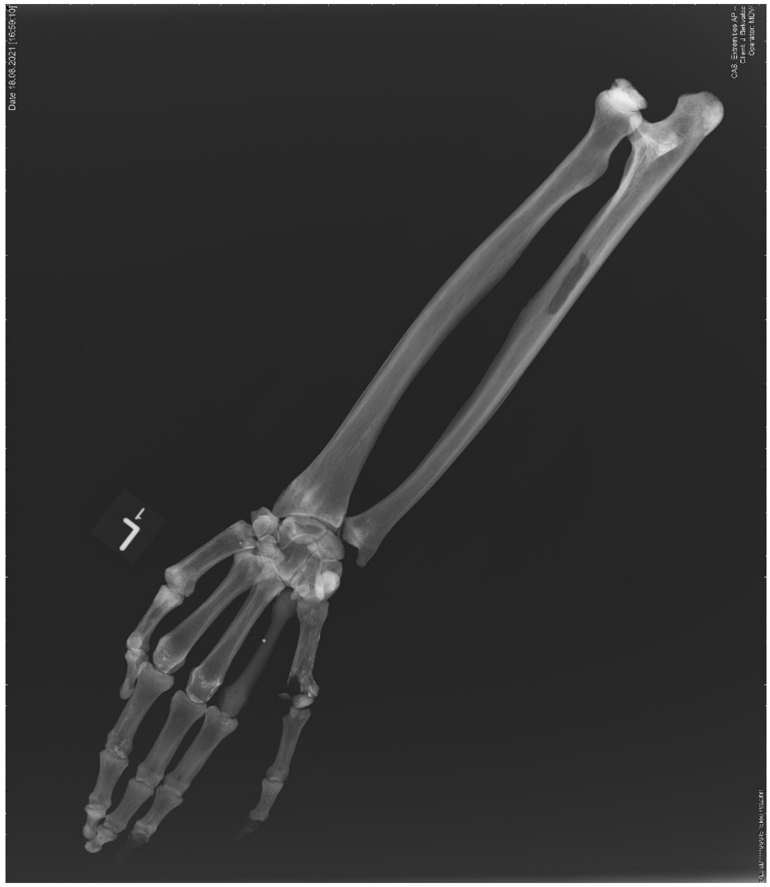

Figure 6:*Radiograph of the Craswall Arm, A-P view.*

2.15 aDNA Analysis

In order to establish the biological sex and possible origins of the arm, aDNA analysis was undertaken at The Crick Institute, London, by Dr. Thomas Booth. Unfortunately, initial screening confirmed that insufficient human DNA was preserved within the bone to proceed with any further analysis (See Appendix A).

2.14 Radiocarbon Dating

Radiocarbon dating was undertaken by the Oxford Radiocarbon Accelerator Unit (ORAU)(Ref C14/5513) on a sample of cortical bone taken from the proximal third of the ulnar diaphysis. The original analysis suggested a date of 955+/- 21 as an uncalibrated BP date, which after calibration gave a date of 1060-1158 (77.2% likelihood at the 95.4% probability level) (Figure 6). However, collagen d15N was measured at 13.5 per mil, suggesting a possible aquatic dietary component and associated marine reservoir effect on the original date estimation. Taking this into account, based on an estimated marine diet of 26% +, the final date was estimated to be 1046-1270 cal AD.

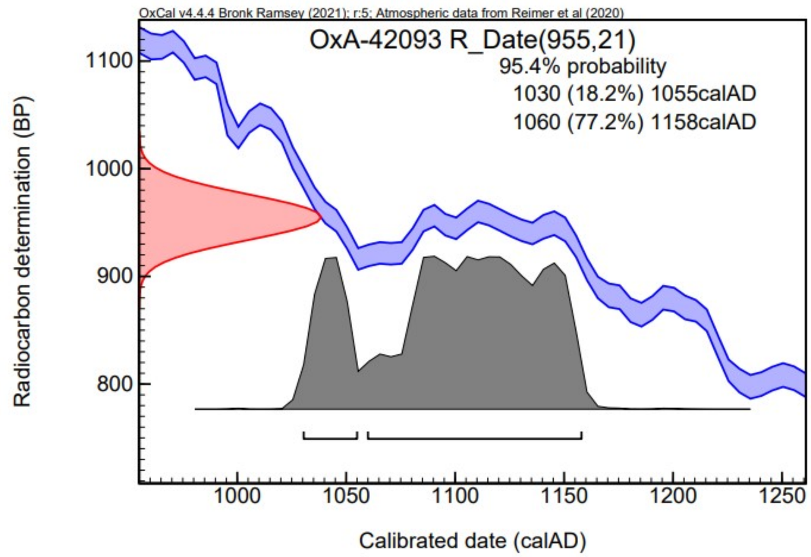

Figure 6:_Calibrated Date Given for the Craswall Arm prior to taking into the account the Marine Reservoir Effect_

2.15 Stable Isotope Analysis

The radiocarbon dating undertakenby ORAU also yielded stable isotope values for carbon and nitrogen, which were analysed by Dr. Joanna Moore and Professor Janet Montgomery (Archaeological Isotope and Peptide Research Laboratory (AIPRL), Durham University), to examine the diet of the individual represented by the arm. They made the following observations:

- The faunal range from Fishergate, York is in good agreement with other Medieval faunal assemblages in England and provides a good baseline for contemporaneous human diet (Muldner and Richards 2005).
- Generally, there is an expected trophic level increase in $\delta^{13}C$ of 1-2‰ and 3–5‰ in $\delta^{15}N$ between someone's diet and their bone collagen values (DeNiro and Epstein, 1978; 1981).
- The Craswall relic exhibits a large trophic shift from the herbivore baseline of +3‰ in $\delta^{13}C$ and +8.2‰ in $\delta^{15}N$.

- The results indicate an adolescent/adult diet containing protein from terrestrial foods native to Britain and Europe (e.g., wheat, barley, root vegetables, animal products) as well as a small contribution from marine resources (saltwater fish, marine mammals, seabird eggs).
- This diet is not consistent with the austere vegetarian diet expected of Grandmontines (Hutchison, 1989 p.194).

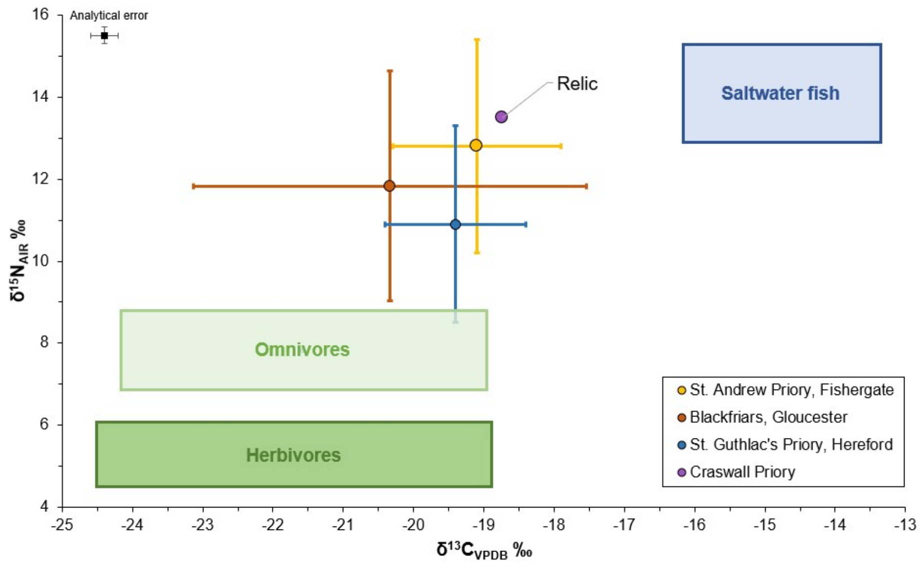

Figure 7: *Craswall Priory relic $\delta^{13}C$ and $\delta^{15}N$ data shown alongside contemporaneous data from England (Halldorsdottir et al., 2019; Spencer, 2008; Muldner and Richards, 2007). Medieval faunal data from York (Muldner and Richards, 2007). All ranges shown to 2 sd.*

3. Conclusion

Osteological re-analysis of the Craswall arm has provided new archaeological evidence that sheds some light on its origin and purpose. Radiocarbon dating has established that the arm dates to between 1046 and 1270 cal AD. This corresponds to foundation of Craswall Priory by Walter II de Lacy c. AD1220 (Hillaby 2014) and gives weight to C. J.Lilwall's interpretation of the arm representing a relic, deposited near the altar as a foundation burial.Osteological analysis confirmed the perimortem severance of the forearm and that this was likely to have been undertaken with skill and some anatomical knowledge. Given its medieval date, the later theory proposed by George Marshall that the arm originates from the bones of the martyred Saint Ursula and the 11,000 virgins of Colognecannot be the case providing that they were genuine.This does not exclude the possibility, however, that a fake relic of Saint Ursula was brought to the priory: The perimortem timing of the removal of the arm as well as the necessary presence of soft tissues at the time of the deposition suggests the arm was not acquired through the excavation of ancient remains that had been interred for any length of time. The relics attributed to Ursula and her fellow martyrsoriginated from the discovery of graves outside Cologne's city walls in AD1155 (Head 1999). These remains subsequently provided a large number of relics to various religious establishments across Europe, including the Grandmontine order (Head 1999, Gaborit 1996).It is highly unlikely these archaeological remains are represented by the Craswall arm, unless the remains exhumed were relatively recent to their discovery.

The origins of the arm are,therefore, still unknown. The sex of the individual could not be identified, though the stature of estimate of 1.70m or 1.71m is closer to the male average of the period. Stable isotope analysis suggested that the diet of the individual was typical of Britain and Europe at this time and included a diet that included marine fish. This was not the diet traditionally associated with the Grandmontine order, which was a notably strict vegetarian one. Archaeological human remains with similar dietary values from medieval sites have been interpreted as being of high status individuals; for example, the stable isotopic values of the Craswall individual are very similarto those recently reported for Richard III (Lamb 2014). Stable isotope analysis undertaken at Hulton Abbey, Staffordshire, a Cistercian House, revealed that individuals buried in the high status area near the altar had consumed more marine fish in their diet, and a similar observation was observed in the skeletal remains of individuals excavated from Whithorn Cathedral priory, Dumfries and Galloway, Scotland, who had been identified as bishops (Müldner 2019).

However, it is also well documented that the early Medieval period, from AD1000, saw an increase in the consumption of marine fish compared to previous periods (Müldner 2019). In York, this trend initially is detected in younger males but over the course of the 11th and 12th centuries, it is clear that a wider demographic, including older individuals and females,was accessing more marine foodstuffs. These marine fish include herring and cod, imports of which increased rapidly over this period, largely tied to what is known as the 'fish event horizon'(Barrett et al. 2004, Müldner 2019). Historical references attest to the wide spread trade in cured herring and cod by the 12th centuries, which Barrett et al. 2004 ascribe to increasing urbanisation and population growth exacerbating declining freshwater fish stocks at this time and the established regulations of Christian fasting.It is unclear then if the individual represented by the arm is of high status or whether the significant proportion of their diet being marine fish was customary at the time.

Following the murder of Becket at Canterbury, the cult of relics experienced exponential popularity between AD1180 and AD1220 (Fitzgibbon 2020) that generated a healthy economy for religious houses based on pilgrimage. However, the Grandmontinesamongst other ascetic orderswere founded on principles of austerity and isolation; this apparently led to prayers being offeredto St. Stephen of Muret, founder of the Grandmontine order,by his successor, prior Peter of Limoges (AD1224-37),asking for a cessationofmiracles in order to avoid the distracting attentions of pilgrims (Head 1999, Gaborit 1996). Gaborit (1996, p.202) further explains that during the time of Stephen of Liciac (AD1136-1163) at Grandmont, the relics of Stephen of Muret were 'withdrawn from their tomb in front of the altar in the chapel to be 'hidden' in the cloister'; they were subsequently returned to the church by prior Peter Bernard (AD1163-70). The remains were documented as still lying in a tomb in AD1190 but its location is not known. This behaviour seems to highlight the need for isolation and for relics to be considered sacrosanct. The Grandmontine order, however, was renowned for the relics it held by the end of the 12th century, and indeed, in 1181, the sixth prior, William of Treignac, dispatched four monks to Cologne to acquire relics, including seven whole bodies of the companions of St. Ursula, two heads and various bones, to be brought back to Grandmont (Gaborit 1996). Inventories of further relics exist and indicate that some were Roman in origin, some had origins in the Holy Land but that the majority evoke other Limousin religious houses (Gaborit 1996). William was of the opinion that the presence of saintly relics inspired devout prayer amongst the brethren and c. AD1190 a redrafting of the Grandmontine custumal states that the brothers should now bow down before the Cross, altar and holy relics (*ante crucem, altare, sacrosanctasreliquias*) (Gaborit 1996).

It islikely then that the burial of the arm at Craswall Priory represents a conferring of saintly blessing as part of consecrating and sanctifying the priory, and was intended to inspire devout religious practice. However, religious orders and monasteries were also enmeshed within complex relationships with the state and the wider population, representing a balance often dominated by their own economic needs and the requisite recognition of the pious devotion of royalty and the aristocracy. It is noteworthy that in many religious houses, the conferring of status and political power was achieved during this period of royal saints by bodily division of royal and aristocratic individuals, allowing the burial of their body parts in more than one location to forge territorial and political links (Binksi 1996). Body parts donated to religious establishments commonly included the heart, head, eyes and intestines. In the absence of effective mummification techniques, the process sometimes involved the removal of soft tissues likely to putrefy rapidly, especially in the hotter French climates, followed by maceration of the body by boiling it in water to reduce it to the far more portable and palatable skeleton (Binski 1996).

Bodily division was popular with the royal and wealthy lay patrons, confirming their stately anointmentand saint-like powers during life, such as being able to touch the sick to cure them, something which was envisaged as extending beyond death in the performing ofposthumous miracles at their tombs. Within the ecclesiastical body, however,the practice of bodily division created a source of great tension, particularly concerning the need for bodily intactness for the Resurrection (Binski 1996). This culminated in Pope Boniface VIII issuing a bull in 1299 (*Detestandaeferitatisabusus:* An abuse of horrible savagery) abolishing the 'detestable savagery…when he has chosen to be buried in his own parts…disembowel him, divide him limb by limb or gobbet by gobbet, and seethe him down in a cauldron' (Binksi 1996, p.67). The move failed however, and bodily division was still practised into the 15th century.

The patronage of the Grandmontine order by royalty is well documented. Empress Matilda (c. AD1102-1167), a granddaughter of William the Conqueror, visited Grandmont and gave Stephen de Liciacthe dalmatic; although she was buried at the Norman Abbey of Bec upon her death, she left 30,000 Angevin shillings to the Grandmontines (Millan-Cole 2015). Her son, King Henry II (AD1133-89) carried on this royal patronage, visiting numerous times, extending considerable financial support to the order leading to at least three foundations in France. It was his wish to be buried at Grandmont and this had been arranged but he was eventually buried at Fontevrault, following his death in particularly hotweather, which foreshortened the transferral of his body (Warren 2000). Prior to his death, his son Henry led a revolt against his father in AD1182 and plundered Grandmont, dying shortly afterwards. Bishop Sebrant-Chabot of Limoges refused to take the entire body, despite his father's patronage, and upon petition Grandmont was only allowed to keep Henry's brain, eyes and entrails (Millan-Cole 2015). The rest of his remains were interred at Rouen Cathedral in Normandy. Walter II de Lacy (AD1172-1241), who founded the GrandmontineCraswall Priory in c. AD1220, had visited Grandmont with King John, son of Henry II, in AD1214, on the Poitou expedition and this visit apparently inspired him to found the priory on the Black Mountains on his lands in Herefordshire 'for the well being of the souls of myself, my wife Margaret and my son Gilbert' (,Hillaby 1985& 2014). The location of Walter II de Lacy's burial is apparently unknown, though he is known to have supported and founded a number of religious houses, including the Cistercian Abbey of Beaubec in Ireland, the Augustinian Abbey of St. Thomas, Dublin and two of his father's foundations, the Benedictine House at Fore in Westmeath and the House of Augustinian canons, St. Mary's, Kells (Hillaby 1985).

Relics could also be used as tokens of exchange between those of wealth and royal status and religious orders. Despite resolutely protecting the remains of St. Bernard of Clairvaux, a finger was gifted to Henry II by the Cistercian order c.AD1170 in exchange for a gift of lead required to restore the church roof at Clairvaux(Fitzgibbon 2020). This was to be the only part of St. Bernard's remains that were translated and it was requested that the finger was kept within its reliquary. However, neither Henry nor his mother Empress Matilda were considered saintly rulers, despite the significant patronage and protection they provided to the religious orders, likely due to behaviours seen as lacking in piety (Martinson 2008).

Osteological re-examination of the Craswall arm drawing together the wider range of current scientific methods has led to a number of interpretive possibilities as to whom the arm belonged to and what the function of its deposition was. While some previous suggestions can now be ruled out, the evidence accumulated so far still leaves questions unanswered, which may prove to provide impetus for exciting new research in the future.

4. Acknowledgements

Osteological analysis of the human remains wascarried out by Gaynor Western (Ossafreelance) Thanks are due to Caroline Hillaby (CraswallGrandmontine Society), Judy Stevenson (Herefordshire Museum Service), JelenaBekvalac (Museum of London), Tom Booth (The Crick Institute), Joanna Moore (Durham University) and Emma Henderson (ORAU) for the provision of contextual and specialist data.Thanks are also due to Jane Jansen and YlberQallaki, National Historical Museums Sweden for their assistance in creating the 3D model available at www.XXXXX/sketchfab.com

5. Appendix A

DNA analysis results:

Sequencing_run	*lims_id*	*Sample_ID*	*Sample_type*	*Description*	*Site_name*	*Age*
211116_A01366_0090_AHHCLNDRXY	SKO719A2293	C11725	Metacarpal	Early medieval possible Saintly Relic from Craswall Priory (martyred virgin?)	Craswall Priory	1.1 kya

Sequencing_run	*Powderfraction*	*Last_Name*	*Last_Name*	*Organization*	*Collaborator_individual_ID*	*seqs_pre_AR*
211116_A01366_0090_AHHCLNDRXY	outer	BOOTH	Western	Hereford Museum Services	501	3126284

Sequencing_run	*seqs_post_AR_gt_35*	*mapped_reads_postfilter*	*pc_mapped_postfilter*	*pc_5p CtoT*	*nuc_coverage*	*assignment*
211116_A01366_0090_AHHCLNDXY	836474	7149	0.85	15.49	0.000107	Not_Assigned

Sequencing_run	*genome_complexity_in_library*	*million_reads_needed_1X*
211116_A01366_0090_AHHCLNDXY	0.3053	8059

REFERENCES

Barrett, J., Locker, A. and Roberts, C.	2004	The Origins of Intensive Marine Fishing in Europe: The English Evidence. *Proceedings of the Royal Society B: Biological Sciences,* pp. 2417-2421.
Bass, W. M.	1995	*Human Osteology; A Laboratory and Field Manual*. Columbia, USA: Missouri Archaeological Society, Inc.,
Binksi, P.	1996	*Medieval Death: Ritual and Representation*. London: British Museum Press.
Brickley, M., and McKinley, J. I. (eds)	2004	Guidelines to Recording Human Remains. *IFA Paper No. 7* in association with BABAO.
Brooks, S. T. and Suchey, J. M.	1990	Skeletal Age Determination Based on the Os Pubis: A Comparison of the Acsadi-Nemeskeri and Suchey-Brooks

		Methods. In *Human Evolution* 5: 227-238
Buikstra, J. E. and Ubelaker, D. H.	1994	*Standards for Data Collection from Human Skeletal Remains.* Arkanasas, USA:Arkansas Archaeological Survey Research Series No. 44.
Cornwall, I.	1966	A Human Relic from Craswall Priory, Herefordshire. Transactions of the Woolhope Naturalists' Field Club, Vol. XXXVIII, Pp. 251-254.
Cox. M.	2000	Ageing adults from the skeleton. In *Human Osteology in Archaeology and Forensic Science* (eds) M. Cox and S. Mays. Greenwich: Medical Media, Pp. 289-305.
CraswallGrandmontineSociety	2023	*C. J. Lilwall Excavations, 1904-8*. https://craswallpriory.org/craswall-new-pages/c-j-lilwall-excavations-1904-8/ Accessed 14/11/23.
DeNiro, M.J. & S. Epstein.	1978	Influence of diet on the distribution of carbon isotopes in animals. *Geochimica et CosmochimicaActa* 42: 495–506.
DeNiro, M.J. & S. Epstein.	1981	Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et cosmochimicaacta*, *45*(3), pp.341-351.
English Heritage	2002	*Human Bones from Archaeological Sites: Guidelines for producing assessment documents and analytical reports*. English Heritage, Centre for Archaeology Guidelines.
Eyer, B.	2022	Pisotriquetral Joint Pathology.*Radsource.* *https://radsource.us/pisotriquetral-joint-pathology/*Accessed 22/11/23.
Fitzgibbon, G.	2020	*For Fear of the Multitudes: Disruptive Pilgrims and Appropriate Audiences for Cistercian Relics in the Twelfth Century.* Unpublished PhD Thesis, School of History and Cultures, University of Birmingham.
Floud, R., Wachter, K. and Gregory A.	1990	*Health, Height and History: Nutritional Status in the United Kingdom 1750-1980.* Cambridge: Cambridge University Press.
Gaborit, J-R.	1996	The Abbey of Grandmont (12^{th}-13^{th} Century). In O'Neill, J. (ed). *Enamels of Limoges*, AD1100-1350. New York: The Metropolitan

		Museum of Art, pp. 54-68.
Halldórsdóttir, H.H., Rogers, B., DiRenno, F., Müldner, G., Gröcke, D.R., Barnicle, E., Chidimuro, B., Evans, M., Morley, R., Neff, M. and Sharp, C.,	2019	Continuity and individuality in Medieval Hereford, England: A stable isotope approach to bulk bone and incremental dentine. *Journal of Archaeological Science: Reports*, *23*, pp.800-809.
Head, T.	1999	The Cult of Saints and Their Relics. The ORB: On-line Reference Book for Medieval Studies. https://web.archive.org/web/20150404034515/http://www.the-orb.net/encyclop/religion/hagiography/cult.htm Accessed 24/11/23.
Henderson, J.	1987	Factors Determining the State of Preservation of Human Remains. In Boddington, A., Garland, A. N. and Janaway, R. C. (Eds) *Death, Decay and Reconstruction: Approaches to Archaeology and Forensic Science*. Manchester : Manchester University Press.
Hillaby, J.	1985 2014	Hereford Gold: Irish, Welsh and English Land Part 2 – The Clients of the Jewish Community at Hereford 1179-1253.*Transactions of the Woolhope Naturalists Field Club, XLV.* Craswall Priory and the de Lacy family:foundation and archaeological history*TWNFC*, 62, pp. 29-73
Hutchison, C.	1989	The Hermit Monks of Grandmont. Cistercian Publications. Michigan USA.
Johnson, B.	2023	Saint Ursula and the 11,000 British Virgins. www.historic-uk.com/HistoryUK/HistoryofEngland/Saint-Ursula-the-11000-British-Virgins/ Accessed 23/11/23.
Lamb, A., Evans, J., Buckley, R. and Appleby, J.	2014	Multi-Isotope Analysis Demonstrates Significant Lifestyle Changes in King Richard III. *Journal of Archaeological Science* (50): 559-565.
Lovejoy, C., Meindl, T., Pryzbeck, T. and Mensforth, R.	1985	Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Age at Death. In *American Journal of Physical Anthropology* 68:15-28

Marshall, G.	1942	*Craswall and Bones of one of the 11,000 Virgins of Cologne. Transactions of the Woolhope Naturalists' Field Club, Col XXXI, Pp. 18-21.*
Martinson, A.	2008	*The Monastic Patronage of King Henry II in England, 1154-1189.* Unpublished PhD Thesis, University of St. Andrews.
Miles, A. E. W.	1963	The Dentition in the Assessment of Individual Age in Skeletal Material. In Brothwell, D. R. (ed) *Dental Anthropology*, pp. 191-209.Pergamon, Oxford.
Millan-Cole, J.	2015	*The Monastic Conversion of Bernard of Clairvaux and its significance for Cistercian beginnings, ca 198 – ca 1128.* Unpublished PhD Thesis, School of Philosophy and Historical Inquiry, University of Sydney.
Müldner, G. and Richards, M.P.	2009	Investigating Medieval Diet and Society by Stable Isotope Analysis of Human Bone. In Reflections: 50 years of Medieval Archaeology 1957-2007, pp. 327-346.
Müldner, G. and Richards, M.P.	2007	Diet and diversity at later medieval Fishergate: the isotopic evidence. American Journal of Physical Anthropology: The Official Publication of the American Association of Physical Anthropologists, 134(2), pp.162-174.
Rainwater, C.	2015	Three Modes of Dismemberment: Disarticulation Around the Joints, Transection of Bone via Chopping, and Transection of Bone via Sawing. In Passalacqua, N. and Rainwater, C. (eds). *Skeletal Trauma Analysis: Case Studies in Context.* John Wiley and Sons. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118384213
Reichs, K.	1998	Postmortem Dismemberment: Recovery, Analysis and Interpretation. In Reichs, K (ed.), *Forensic Osteology: Advances in the Identification of Human Remains,* 2nd edition, Springfield, IL: Charles C Thomas, pp. 353-88.
Roberts, C. and Cox,	2003	*Health and Disease in Britain from Prehistory to the Present Day*.

M.		Stroud: Sutton Publishing Ltd.
Roberts, C and Manchester, K.	1997	*The Archaeology of Disease.* Stroud: Sutton Publishing Ltd.
Schaefer, M., Black, S. and Scheuer, L.	2009	*Juvenile Osteology: A Laboratory and Field Manual.* London: Elsevier Academic Press.
Seetah, K.	2019	*Humans, Animals, And the Craft of Slaughter in Archaeo-Historic Societies.* Cambridge: Cambridge University Press.
Smith, B.H.	1991	Standards of Human Tooth Formation and Dental Age Assessment. In Kelley, M &Larsen , C. S. (eds) *Advances in Dental Anthropology*. New York: Wiley-Liss, Pp 143-168.
Spencer, R.	2008	Testing hypotheses about the aetiology of DISH using stable isotope analysis and other techniques. Unpublished PhD dissertation, University of Durham, UK.
Stuart-Macadam, P.	1991	Anaemia in Roman Britain. In H. Bush and M. Zvelebil (eds) *Health in Past Societies. Biocultural interpretations of human remains in archaeological contexts.* Oxford, Tempus Reparatum, British Archaeological Reports. International Series 567, Pp101-13.
Trotter, M.	1970	Estimation of Stature from Intact Limb Bones. In Stewart, T. D. (ed.) *Personal Identification in Mass Disasters.* Washington DC: Smithsonian Institution, Pp.71-83.
Tyrell, A.	2000	Skeletal non-metric traits and the assessment of inter- and intra-population diversity: Past problems and future potential. In *Human Osteology in Archaeology and Forensic Science*(eds) M. Cox and S. Mays, Greenwich: Medical Media, Pp 289-305.
Ubelaker, D.	1989	*Human Skeletal Remains*. 2nd ed. Taraxacum Press, Washington D.C.
Warren, W.	2000	*Henry II.*New Haven, CT: Yale University Press.