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Excavation and post-excavation treatment of cremated and inhumed human remains

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It is the aim of this technical paper to provide procedural advice which will enable the excavator to extract the maximum useful data as quickly and efficiently as possible. Excavation and post-excavation treatment of human remains, cremated or inhumed, will affect the quality and quantity of information the human bone specialist will be able to extract during examination.

All excavation of human remains, cremated and inhumed, requires, in England, a licence from the Home Office, with the exception of excavation in consecrated ground. Burials in consecrated ground fall under ecclesiastical jurisdiction and excavation requires a Faculty. Since most excavations under these conditions are likely to have been requested by the Church, this requirement will probably be obtained internally. For application procedure and details of the laws concerning the excavation of human remains, see Garratt-Frost (1992) and Logie (1992) with reference to Scotland. In the case of accidental disturbances a licence may be obtained by telephone (see Harrison 1992).

I Excavation

Where the presence of human remains is known of in advance of excavation, the human bone specialist should be involved in the project at the outset. This will enable them to give site-specific advice to the excavators and thereby exploit the maximum potential of the cemetery.

When any excavation of a cemetery or burial is to take place, it is advisable to **familiarise the site personnel** with what to expect. The fact that all excavators have a skeleton does not ensure their knowledge of what one looks like.

Wherever possible, but particularly on a large cemetery excavation, it would aid the excavators' interest and understanding (thereby enhancing the speed of excavation – often an important proviso), to have a demonstration by a human bone specialist of a neonate/infant skeleton (which can have a distinct likeness to rabbit/dog bones for the uninitiated), a juvenile and an adult skeleton. For example, figures 1 and 2 show the femora of individuals ranging from infant to adult, illustrating the similar morphological appearance but the great difference in size. Similarly, figures 3 and 4 show the first metatarsal (big toe) and the vertebrae from individuals covering a range of ages, from infant to adult, and illustrate the somewhat unexpected appearance of immature bones.

Ideally, the specialist should be available on site at all times. Unfortunately, the ideal is not always possible but, certainly on a large cemetery excavation, costing should be included to allow the human bone specialist to visit the site

Figure 1 Showing the left femora from individuals of various ages, neonate (right) to juvenile (left). NB the epiphyses (secondary centres of ossification) are missing from most of these examples.

regularly – this will be advantageous both to the specialist and to the excavators. The interpretation of skeletal analysis is enhanced if the osteologist is familiar, at first hand, with the characteristics of the site and excavation. Where human bone is to be immediately reburied a bone specialist should always be on site during excavation.

There are a number of visual aids which should be provided on site, with instruction to peruse. Invaluable in this respect is the fold-out *The human skeleton: a photographic*

Figure 2 Showing the left femora from individuals of various ages, juvenile (left) to adult (right).

Figure 3 The left first metatarsal from individuals of different ages, neonate (right) to adult (left). NB The epiphyses are missing from the three youngest examples.

Figure 4 Vertebrae from individuals of different ages, neonate (left) to adult (right).

manual by McMinn, Hutchings and Logan (1987), which has almost life-size views of the skeleton from various angles, and can be hung in a Site/Finds Office, or the sheets could be separated and mounted on boards for easier access (it is not too expensive at *c* £16). Excavators should be made aware of what to expect in material terms when excavating skeletons (if a reference skeleton can be obtained this would be better still).

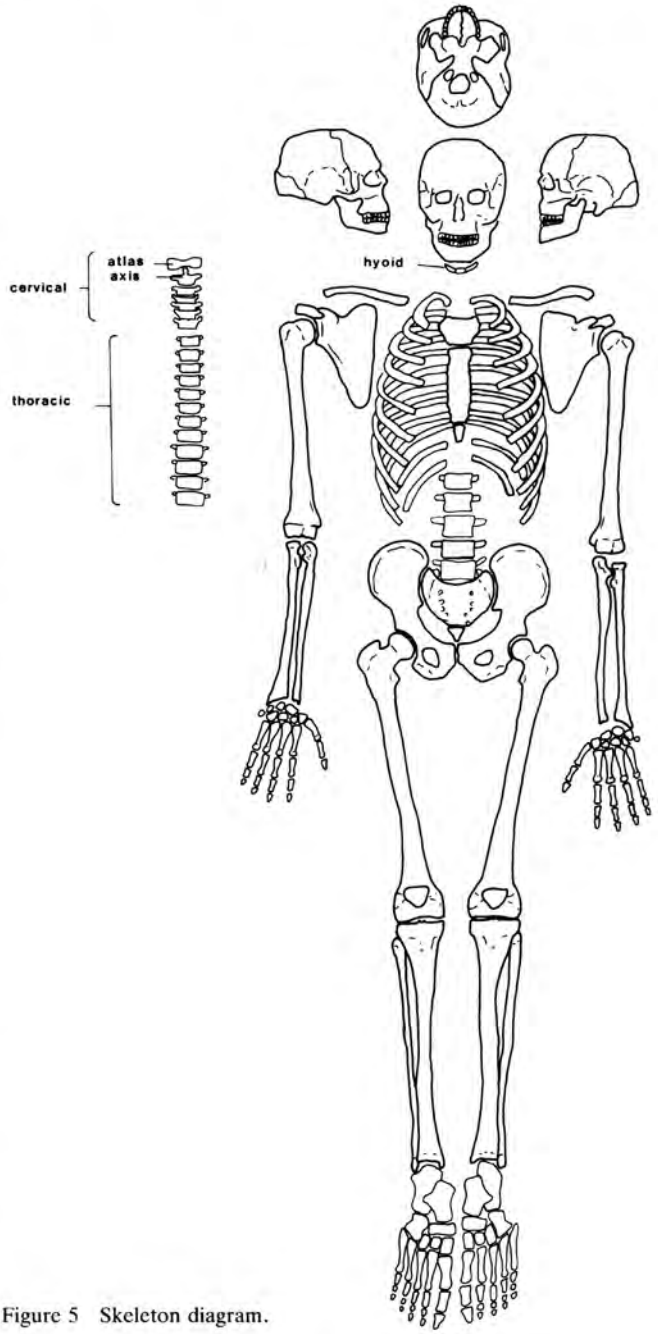


Figure 5 Skeleton diagram.

A burial, be it a cremation or an inhumation, should be regarded as a 'context' not a 'small find'. The remains constitute part of the fill (a deliberate fill) of a cut, ie the grave or pit. A Skeleton Sheet should be used on site in place of, or in addition to, an ordinary Context Sheet, but it is important to later analysis that the excavator records all relationships as they would for any other context. This information may be of vital importance to the human bone specialist at a later stage, particularly on a disturbed site where admixture of closely spaced burials may have occurred.

With regard to cremation burials this need for contextual information must be emphasised. If a single bone from a second individual is identified in a cremation burial, it is of vital importance that contamination from a disturbed neighbouring cremation can be eliminated as a source. Any level of disturbance should be recorded, with details of how far the disturbance extends, eg the upper 5cm of a burial or the whole thing, and with a note of any possible source of contamination.

Care should be exercised at all times. Bone, both inhumed and cremated, is fragile and may fragment easily – this creates more work for the human bone specialist and therefore extra cost, and may destroy important evidence.

Cremated bone is particularly brittle and the bone will fragment further on excavation (see McKinley in press a); this should be minimised by careful handling and frequent dampening of the soil to make the bone easier to lift (if the cremation is in an intact urn this is not an on site problem). Increased fragmentation of cremated bone makes it both more difficult to identify and has repercussions for the interpretation of pyre technology and ritual (McKinley 1989).

The production of a skeleton report by the osteoarchaeologist is made easier if skeletons are excavated in as complete a state as possible. Some burials may be so fragmentary that very little information about the individual can be generated, but total excavation of the skeleton should be the primary aim, although it is accepted that site specific (and grave specific) conditions may prevent this occurring. Unnecessary fragmentation of bones may increase the difficulty of ageing and sexing the individual, and whole bones are needed to enable measurements to be taken. The study of palaeopathology in particular, necessitates consideration of the whole skeleton, as specific diseases can only be diagnosed by assessing all the skeletal elements. For example, without the hand and foot bones it is not considered possible even to attempt to diagnose pathological conditions such as rheumatoid arthritis (see Waldron 1987).

The burial environment will determine the survival of any skeleton. Physical, chemical and biological factors delay or advance decay; particularly, soil pH, moisture content, air, temperature, fauna, flora and living humans (Henderson 1987). The size, shape, density, sex and age of the skeletal elements, and any pathological conditions present, will also affect preservation.

The procedure for excavation of inhumation (including disarticulated) and cremation burials obviously differs slightly and will be considered separately.

Inhumations

A skeleton is three-dimensional, and the individual bones may not always appear where you expect them to, eg if the body was buried supine (on its back) with the knees bent up, you may find the patellae (knee caps) before anything else. There is also the problem of post-depositional movement or later disturbance of a grave, and in some cases deliberate deposition of disarticulated bone, in consequence of which a bone may be found in an unexpected position.

Care should be taken in excavation to disturb bones as little as possible (not always an easy task). Excavation using a plasterer's leaf, teaspoon and small paint brush will prove most effective. Where bone is delicate plastic spatulas or a smaller wooden implement such as a cocktail stick may be of use and cause less damage. However, overcleaning may cause more harm than good if the bone is fragile. It is useful to shade the bone from strong sunlight when first uncovered, since damp bone should be dried slowly to avoid cracking and flaking. Try spraying the bone lightly with water, and if possible excavate in one day as this is less damaging to the skeleton – ie avoid starting to excavate late in the day. If it is not possible to excavate all in one day, cover the skeleton with polythene overnight to keep the bone damp. Infant and juvenile bones are very small and fragile and will require extra care.

Avoid using a consolidant such as polyvinyl acetate (PVA) unless vital, but if it is used ensure the bone is free from all soil first. This is effectively a glue and gluing soil to the bone is not helpful. Only workers experienced in the use of consolidants should use them. Incorrect usage could be a disaster. Always keep clear records of what has been used and beware of using on bone which may eventually be needed for chemical analytical techniques. See Spriggs (1989) and Watkinson (1987) for details of on and off site conservation of bone.

Ensure the bone is fully uncovered before proceeding with final recording and lifting; this will make it easier to draw, give clearer and thereby more useful photographs, and enable the excavator to check all bones are present.

It is usual to record an inhumation on a specially designed **Skeleton Record Sheet** rather than, or in conjunction with, an ordinary Context Sheet. Most organisations will use their own skeleton record sheet design but there are a number of features which they all should carry, and a number of points designers should remember when constructing them.

It is pointless to make any context sheet over complicated – it makes no difference how 'brilliant' the designer may consider it, if it is not filled out on site it will be of little use, and the less complex the form is, the more likely it is to be completed properly, especially when under stress from lack of time.

Remember this is a site context sheet to be filled in by site excavators not bone specialists. It is a waste of precious 'on site' time and money to have untrained personnel guessing age, sex and pathological conditions when at a later date a specialist should be providing this data. It is far more important that the excavator – who is a specialist at her/his job – records contextual data; once this is lost it cannot be regained. However, where fragile bones exhibiting pathological lesions are likely to fragment badly on lifting, thereby potentially obscuring or losing information, close-up photographs of the bone should be taken prior to excavation, with a description of its condition.

Most sheets will include a skeleton diagram similar to figure 5, on which the bones present at excavation are to be shaded. An accurate representation of the bones, where all can be viewed, will aid the excavator both in recovery and correct completion of the sheet. The various views of the skull, and displaced cervical and thoracic vertebrae enable shading of bones which would not be seen in one plane. The slight 'explosion' of the hands and feet ensure each bone may be counted and shaded – where not all bones are present, it is unlikely that a non-specialist would be able to identify each carpal/tarsal, metacarpal/tarsal and/or phalanx to the precise bone, in which case counting and shading the correct number of each would be all that was necessary. At birth, there are 450 bone forming (ossification) centres in the skeleton, which will eventually develop into 206 bones in the adult. An awareness of the potential number of bones to be excavated is necessary if complete recovery is to be achieved. Care should be taken to ensure that the correct number of vertebrae, ribs, hand and foot bones are shown in each

section. The excavator should be aware, however, that 'extra' bones may occur within a skeleton, eg there may be thirteen rather than twelve thoracic vertebrae, or six rather than five lumbar vertebrae.

Some Skeleton Context Sheets duplicate information by having boxes to tick down the side of the skeleton diagram; this is not really necessary. Two additional boxes should be provided however: (1) for the hyoid bone, which could be shown on the diagram but is often not included (and, perhaps coincidentally, is often missing from skeletal material). This is a light, spongy, 'U-shaped' bone located in the mandible/anterior neck area; (2) for sesamoid bones, which are additional small bones which may be found in the hand or foot; numbers found should be noted.

Other data recorded on the sheets should include condition of the bone, whether the skeleton is articulated or disarticulated, a note on how complete the skeleton is, orientation and position or posture. There are any number of variations in the position an inhumation may be found in, but there are a few basic positions:

extended – body straight out

crouched – body, legs and usually arms, curled up in what is sometimes called the 'foetal' position (figure 6). The knees are to the chest, the back and head often curled and the arms tucked in.

Figure 6 Crouched inhumation (photograph by kind permission of Wessex Archaeology).

flexed – the legs may be flexed just slightly to one side or up at right angles portraying a 'seated' posture (figure 7, the legs are tightly flexed but the basic position is different from that in figure 6). Flexed only becomes 'crouched' when the knees are folded as described above. The arms may also be flexed in any variety of positions.

supine – on the back

prone – face down; care should be taken to ensure a genuine prone position ie placing of the body on its front, and that part of the body has not merely slumped forwards from an 'on the side' position.

on right or left side

Figure 7 Flexed inhumation (photograph by kind permission of Wessex Archaeology).

Other contextual data normally recorded on any context sheet should also be included.

Disarticulated human bone from non-burial contexts are normally recorded as context finds. On some sites however, eg Neolithic long barrows, finds of such bone would benefit from more detailed recording including a plot of exact location or three-dimensional record, ie treating individual bones similar to small finds.

Plans showing contextual relationships, as with any other context, should always be made, though the skeleton itself may only be represented schematically. Detailed plans of the skeleton are only of use if the illustrated bones bear a remote resemblance to reality. Good skeleton drawings are not only useful but aesthetically pleasing for publication. But such plans may take a long time to produce on site, and if time is limited it may be of more use to take good quality photographs. Vertically orientated photographs with a grid have been used successfully to plan from in post-excavation, but the quality and accuracy of the photograph is essential. A good, clear plan and photograph are recommended wherever possible.

If something looks anatomically abnormal in the ground a close-up **photograph** should be taken, this may be of use to the specialist in pathological diagnosis. Figure 8, taken of an

Figure 8 Lower limb bones from inhumation excavated at St Giles medieval cemetery, Yorkshire (photograph by kind permission of North Yorkshire County Council)

inhumation from the medieval hospital of St Giles in North Yorkshire, shows the rotation of the right leg characteristic in clinical cases of a condition called slipped femoral epiphysis. Corresponding pathological changes in one of the individual's hips were noted (Knüsel *et al* 1992). Illustrations will support written records and probably give a clearer indication of body posture, position of any grave goods, and association with neighbouring burials – some of which may be difficult to interpret accurately during excavation.

When **lifting** the bones they should be bagged by skeletal area – skull, axial, upper and lower limb – with separate bags for the left and right side. This will ensure the bones are not packed too tightly, speed up procedure in post-excavation, and provide a check for the recorded skeletal position. Where there are many intercutting graves, or in adverse site conditions, what may appear to be a supine burial could be prone and vice versa, by labelling left and right there is an additional check to be made by the human bone specialist.

Where they may be reliably identified (ie in relatively undisturbed graves) it is helpful for the fourth ribs to be placed in separate bags. This will assist age assessment.

Sampling of grave deposits should be undertaken in conjunction with the human bone specialist and/or environmental archaeologist working on site. Potential information from soil samples is obviously determined by the soil condition, particularly its Ph and moisture content. For example, pollen, seeds, insects and parasites are usually preserved in acidic waterlogged environments, and may provide information on diet, environment and parasitic infections. However, care in interpretation is advised because of unknown post-depositional changes to the contents of graves (see Evans (1978) for more information on environmental evidence). In certain special cases, the human bone specialist may wish to undertake particular analytical techniques such as trace element analysis (see below). If so, it will be necessary to take soil samples from around the skeleton to provide a check for the effects of diagenesis. Such sampling would need to be discussed with the specialist in advance of excavation.

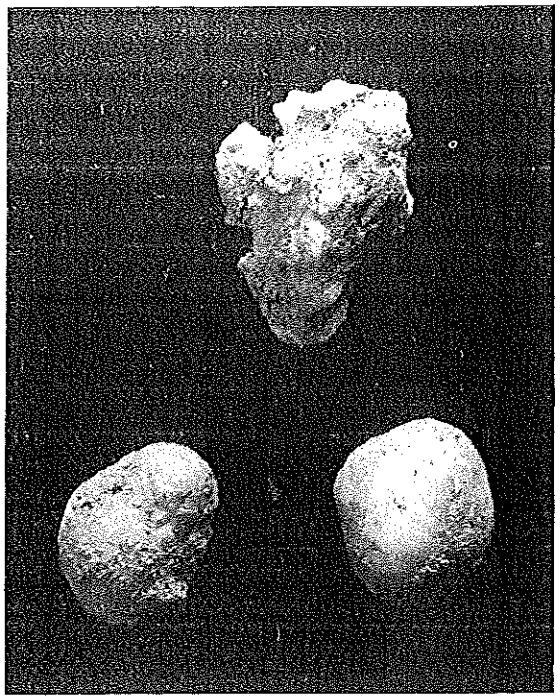
In some rare burials where body tissues are preserved, eg peat bog burials, sampling of the abdominal areas may provide evidence of, for example, diet. In routine cemetery excavations, taking samples for extraction of environmental evidence is not recommended in all cases. It is, however, advised that soil from the abdomen, chest and neck areas of the skeleton is retained and sieved using a 2mm mesh in order to recover any calcified soft tissues, calcified masses (eg gall/bladder/urinary stones) or foetal bones which may have been overlooked by the excavator. Figure 9 shows a calcified thyroid cartilage from the neck region; figure 10 shows calcified rib cartilage; figure 11 shows several different forms of gall and kidney stones. A surprisingly small number of 'stones' are recovered from archaeological inhumations – only a handful have been recorded from Britain (McKinley and Garland 1989, McKinley forthcoming a & b, in press b) – but they are likely to have been far more common. 'Stones' is an excellent description, since this is exactly what they look like and it is easy to see why they are rarely recovered. They may occur singly or in large numbers, vary in size from a few millimetres to 30-40mm, and in shape from spherical to something resembling a coral (Steinbock 1989 a, b and 1990). Sampling is the only realistic way to recover these items.

It has been demonstrated that sampling from around the hands and feet results in greatly improved bone recovery, especially with immature individuals since epiphyses can be very small (Keilly 1989). It is advised that such samples should always be taken unless the excavator is positive all the bones have been recovered. Samples should also be taken from the head area to recover any loose teeth which may have fallen out of the sockets. Once the skeleton is lifted, it is recommended that the layer of soil below the skeleton be collected and sieved (2mm mesh) to ensure no small bones or teeth have been overlooked in excavation.

Decisions regarding sampling should be made prior to excavation with input from the archaeologists and specialists concerned. Conditions will obviously vary between projects depending on site specific questions to be addressed, time available, etc.

Figure 9 Calcified thyroid cartilage

Figure 10 Calcified rib cartilage



Figures 11a and b Gall and kidney stones from Romano-British inhumation burials (scale x4)

Cremations

A cremation burial may be urned or unurned, in a pit, a cist or may appear to have been placed on the ground surface with no obvious cut.

A complete, **undisturbed urned cremation** should be lifted intact, first bandaging the vessel to give added support on lifting. If the urn is inverted, bone which has slumped out of the fill into the pit should be bagged separately.

If the vessel is lidded and no soil has entered during burial, extreme care should be exercised not to shake or disturb the contents in any way from their original position.

A smashed urn may need to be excavated on site. In the case of disturbance there is little to be gained from bagging any of the bone separate from the rest as any original deposition of bone will have been disturbed. The surrounding soil should be dampened during lifting in order to minimise further fragmentation of the bone (see McKinley in press a for factors affecting cremated bone fragment size).

Unurned cremations have to be excavated on site, again dampening the surrounding soil to minimise fragmentation. Where the burial has been disturbed there is no point in bagging the bone in spits or other divisions since any original order of deposition will have been lost. Where a burial is undisturbed, it may be considered useful, time permitting, to excavate the deposit in spits. If this is done, then it must be carried out in uniform spits – 20mm spits are advisable, certainly no smaller. All bags must be clearly labelled with the spit number. There is no point in excavating a burial in arbitrary divisions with no explanation of how they relate for the human bone specialist.

All bone fragments down to 2mm should be collected for examination. To ensure the recovery of such small fragments from an unurned cremation or urn pit fill where spillage has occurred, the soil around the cremation deposit should be kept, as should other parts of the pit fill which appear to contain bone. These samples should be wet-sieved through a 2mm mesh sieve for bone recovery. In the event that the pit fill contains pyre debris, evidence of organic pyre goods, eg foodstuffs and wood species used in the pyre construction, may be obtained. In these cases, 100% samples of the pit fill should also be taken for recovery of plant and animal remains.

The excavator should record the presence of any associated deposits of pyre/grave goods including unburnt bone. Any pyre debris (this may include charcoal, burnt flint and fuel ash slag – see McKinley 1989, forthcoming b, in press b) should be noted on the context sheet with some comment on quantities present, and where this debris is in relation to the cremated bone. Any discolouration to the sides of the pit/cist suggestive of burning/scorching should be noted.

Should a cremation burial be recovered in waterlogged condition, the bone should be kept damp (see section II).

A cremation burial will normally be recorded on an ordinary context sheet and the stipulations outlined above with regard to disturbance and associations should be followed. The maximum size of fragments prior to lifting (skull and long bone if possible) should be recorded.

There may be evidence of **pyre sites or dumps of pyre debris** in a cremation cemetery. These may appear as spreads of burnt material, or discrete areas of *in situ* burning possibly with an associated shallow scoop (see McKinley forthcoming c, in press a). As individual pyre sites may only have been used once, these layers may be thin. If such an area is discovered, it would be advisable to notify the specialist so they may view the area. The context should be lifted and treated as an environmental sample; it may contain fragments of cremated bone and pyre goods, the latter may include charred organic material. Species analysis of the charcoal may suggest details of the pyre construction.

Health and Safety

Health and safety on excavations of any type is a priority, and all sites should appoint a Safety Officer. Archaeologists

regularly question the dangers of excavating human remains and myths are created regarding the contraction of infectious diseases, but for the majority of cemetery excavations in the UK these risks are unfounded.

The majority of sites date to several hundred years or more ago, precluding the survival of any disease-causing organisms. A special problem is created when dealing with **crypt populations** which often contain **sealed coffins,** commonly constructed of lead, and of recent date. Particular potential hazards include fungi and the presence of soft tissue. In these instances (and any others that you are unsure of) advice from the local Health and Safety Executive should be sought, as there are currently no agreed safety procedures for dealing with these situations. Sealed lead coffins in particular should be left to be opened by non-archaeologists in a controlled environment.

The only possible risk in terms of infectious diseases are smallpox, the spore producing conditions of tetanus and anthrax, and the mycoses or diseases caused by fungal growth, but these risks are only a problem when dealing with very recent burials (in the last 50 years). Tetanus is caused by the bacillus *Clostridium tetani* whose spores inhabit soil, particularly that contaminated by organic remains, living especially a short distance below the ground surface. Tetanus can be a hazard on any archaeological site and all workers should be immunised against it. Following a course of 3 injections, booster doses at 10 year intervals are required.

Smallpox is an acute, highly infectious disease contracted through direct contact of skin lesions or droplet infection. It was known in England as early as the 13th century, but by means of a mass vaccination programme the last naturally occurring case was recorded in October 1977. There is evidence to suggest that the virus becomes inactive in skin lesions of smallpox within a year or two (Zuckerman 1984). Therefore, there appears to be no risk to excavators on archaeological sites, although when preserved bodies are being excavated in dry or permafrost conditions, it is possible that the virus could survive longer (Baxter *et al* 1988). In fact, Fornaciari and Marchetti recorded one such case (1986).

Anthrax is a very serious disease occurring in sheep and cattle, and in people in contact with these animals' products. It is now rare in the UK. Between 1961 and 1980 there were 145 cases, 12 of them fatal in England and Wales. The bacillus causing the disease is *B anthracis* and it produces spores of great vitality. The disease is contracted from a diseased animal through the skin, by inhalation or via the digestive tract. It is unlikely that anthrax spores could survive for more than 100 years, but suspicious environments are dry, dusty contexts where spores can survive. Again, contact with the Health and Safely Executive is advised in suspicious circumstances.

II Post-Excavation

Procedures vary slightly for cremations and inhumations, therefore they will again be considered separately. Discussion of post-excavation procedures should take place between the specialist and the archaeologist prior to commencing work, in case of any special needs.

Inhumations

Cleaning: where the soil type allows, ie in a very light soil, the bone may be dry brushed. Also, if the bone is very fragile, dry brushing may be preferable. Where the bone cannot be adequately cleaned in this way, it should be washed using a bowl of cold or tepid (not hot) water, and a soft toothbrush or paintbrush (Stroud 1989). The bone should not be immersed in the water since it takes a long time to dry wet bone and if fragile it may disintegrate. Small bones may be placed in a small mesh (2mm) sieve – a kitchen sieve will do – and be dipped in the water to remove the soil.

Particular attention should be paid to the broken ends of bones to leave them clean for any possible reconstruction, but the bone must not be scrubbed as this may prevent accurate reconstruction. The ear orifices should not be cleaned out as this may result in the loss of the inner ear bones. Care should be taken with teeth as calculus deposits (hard, calcified plaque) may break off, destroying evidence – do not brush with a toothbrush. The facial bones are very fragile; if in doubt about cleaning, the maxilla and mandible may be left for the specialist to clean.

There may be instances in which artefactual staining is present on the bone, eg ochre. This should not be cleaned off; if in doubt consult the specialist.

Wet bone should be allowed to dry slowly. Do not place it in direct sunlight as this may resulting in cracking or flaking of the bone.

Marking: all the bone should be marked with its unique ID number in indian ink, but never write on an articular (joint) surface as this may obscure pathological lesions. Likewise, obviously abnormal bone should not be covered. If there is no alternative leave the bone unmarked. Provided the bags are labelled properly with labels inside there should be no difficulty with discrete inhumations.

Where disarticulated bone has been recovered it is advisable to mark all the bone. This will aid the specialist during analysis for minimum numbers etc.

All **reconstruction** should be left to the human bone specialist.

Packing: bone may be stored and labelled as directed above, in either paper or polythene bags; the latter make examination easier and are usually sealable which will minimise loss. Always ensure bone is thoroughly dry before packing as it will go mouldy and may disintegrate otherwise; if in paper bags the bags may deteriorate too. A suggestion would be to use paper bags for packing until the bones are clean and dry; and then place in plastic bags.

Fragile bone fragments, eg the maxilla or bone with gross pathology, may benefit from the extra protection of packing in acid-free tissue. It is not normally necessary to wrap each bone of the skeleton individually, only where fragile. Overkill on wrapping is both frustrating to deal with and a waste of resources.

Pack the bone with care, do not try to cram too much into one box as it may break the bones. Use proper boxes not cereal crisp boxes as these are not robust enough and often collapse, and storage is made very difficult where boxes of many different dimensions are used. If boxes are not full, packing paper may be used to fill in the spaces. The base of boxes may be lined with paper (newspaper may be used provided the bone is in bags as newspaper is acidic) to cushion the bone when being transported. It is recommended that all bone should be packed in acid-free boxes. The use of separate, specifically dimensioned, skull boxes is recommended for added protection and ease of bone storage.

Systematic context numbering is in part designed to ease speed and accuracy of recovery of material. Always ensure contexts are boxed in numerical order. If a context has to be split between two or more boxes ensure they are in sequence and label boxes '1 of 1', etc. All boxes should be clearly

labelled with the numbers of the contexts they contain. It is both annoying and a waste of time and energy for the specialist to find odd bits of bone from one context spread between several non-sequential boxes.

Museums and other storage areas should first consider the size of all the material it may be necessary to store before deciding on the size of their shelving. Boxes used for storing human bone must be large enough to accommodate a complete adult femur (length 50cm most suitable). Reports of boxes stored with holes cut in the front to allow the femur to protrude or bones broken to fit into boxes are somewhat distressing but apparently true! This is not acceptable.

Storage should be in a cool, dry place at between 45% and 70% relative humidity with minimum fluctuation.

Boxes should not be overstacked, as the pressure from the uppermost boxes could crush the ones underneath. Stacking directly on the floor should be avoided as the boxes may become damp.

Cremations

Urned cremations lifted intact from site: where possible these are best emptied by the human bone specialist and this is particularly important for lidded urns with no soil infill. Additional information on pyre technology and cremation ritual can be gained by the specialist who will identify and record the bone as it is extracted (see McKinley forthcoming a). If it does not prove possible for the urn to be emptied by the specialist, the contents should be removed in uniform 20mm spits, dampening the soil to minimise fragmentation, and clearly labelling the spits. The largest fragments of skull and long bone should be measured prior to removal.

Cleaning: the bone should be dry, or more often, wet sieved with care to minimise fragmentation, using a stack of 10, 5 & 2mm mesh sieves for ease and maximum recovery of bone. It is not necessary or advisable to wash individual bones separately. Where possible, large stones should be removed prior to sieving as their presence may result in increased bone fragmentation (McKinley in press a).

Once the bone is dry, extraneous post-depositional material – stone and peagrit – should be removed, at least from the >5mm fraction. Transporting brittle cremated bone with heavy extraneous stone amongst it may lead to increased fragmentation of the bone. Any pyre/grave goods, or pyre debris removed at this stage should be recorded. Should removal of all peagrits from the cremation appear impractical in terms of time and finance, the specialist should be consulted further and an agreement on procedure obtained. It is necessary to weigh the bone in order to assess the proportion of the remains collected from the pyre for burial, as up to 40% of a cremation may be in the 2-5mm range; having to approximate this weight of material due to it containing large amounts of peagrits can be detrimental to the study of the technology and ritual aspects of the cremation. Less extraneous material in the cremation also increases speed and accuracy of identification of bone fragments. Where post-excavation personnel are unsure of the nature of any fragment within the cremation (eg a possible gall/kidney stone) it should be left for the specialist to examine.

A waterlogged cremation should be kept damp and cool until it can be conserved. If it is necessary to remove the bone from its burial medium, it should be stored in acid free polythene boxes, lightly sprayed with distilled water and kept refrigerated.

Packing: once dry, cremated bone should be packed in sealable polythene bags, clearly labelled and with a label inside the bag.

It is not generally practical to mark cremated bone.

Packing should again be done with care. Although several cremations may be stored in one box, it is not advisable to overpack boxes or put layers of bags one over the other since this may result in further fragmentation of the brittle bone.

Notes on general packing and storage discussed above would also apply to cremations.

III Application of Physical and Chemical Techniques

There are a number of analytical techniques available which may be applied to human skeletal material. However, the techniques are destructive and relatively expensive. The relevant techniques are summarised here and readers are referred to key references. It should be noted, as with any buried material, that human remains are subject to changes in structure due to intrinsic and extrinsic factors which may affect its suitability for scientific analysis (Boddington *et al* 1987).

Dating of Bone: the use of dating in the assessment of cemetery populations should be considered carefully. The archaeological questions to be answered should be formulated before the process is set in motion by direct discussion with the dating laboratory. Reasons for obtaining a date for a skeleton may be, for example, to provide a date for a specific burial or to fill a gap in the history of the development of a specific disease. More general reasons may be to establish or strengthen the basic chronological framework of a region or to date a site (Aitken 1990). In most cases the technique of radiocarbon ^{14}C dating would be the most appropriate to use, giving dates of between 400 and 50,000 years old. The cost currently stands at between £300 and £400 per date.

The technique demands extraction of the protein fraction (collagen) of the bone. The environment of deposition of the burial, post-depositional changes and the age of the burial, will determine the amount of collagen which will be present in any bone; the less collagen, the more bone is needed for analysis. (Cremated bone is usually not suitable for this type of analysis. The process of cremation is one of oxidation of the organic components of the body and little or no collagen remains in the bone). Depending on the collagen (protein) content of the bone, between 100-500gm of bone are needed for a conventional date, whilst 0.5-5gm is often all that is needed for the more recent (but more expensive) method of accelerator dating (Aitken 1990). Details of collection of samples and associated information is available from the appropriate laboratory or by consulting Gillespie (1984).

Chemical analysis of bone: an abundance of literature exists on the chemical analysis of human bone, concentrating on questions such as palaeodiet, eg the change from hunter-gather to an agricultural economy, and occupational health, eg exposure to lead. There are a multitude of methods available for chemical analysis and their use is becoming more common, especially in research projects.

Palaeodiet can be investigated by analysing trace elements in bone samples indicative of particular food resources. For example, foods of animal origin have higher concentrations of elements such as zinc and copper than those from plants (Sandford 1992). Assessing elemental constituents of past diets, and the effect of food preparation techniques on

dietary content have their problems however, particularly the effect of soil and water element concentrations in the grave. Another method of palaeodietary analysis is to measure the stable isotopes of carbon and nitrogen (Katzenburg 1992), where the problems of diagenesis are believed to be less cause for concern. Given the problems with the analysis of elements in bone, it is unlikely that in a 'normal' cemetery excavation this area of study will be proposed, unless the project is more research orientated. Such work is more probable following excavation and storage of the material. It is advisable to consult the human bone specialist responsible for the skeletons about this area of the study.

NB Once again, the use of cremated bone in this area of study is severely limited as a result of the chemical changes undergone during cremation. Although there may be some potential, little work has yet been done with cremated bone.

Molecular analysis of bone: there is increasing interest in the extraction of blood constituents (Cattaneo *et al* 1992) and DNA from human bone to provide information about, for example, human evolution, disease and genetics. The latter may, in the future, also lead to more detailed discussion on population migration and diffusion, and family relationships (Brown and Brown 1992). However, the problem of contamination of bone samples is significant pre-, during and post-burial, especially in the case of DNA recovery. Contamination between death and burial by handling of the body by attendants, infiltration of DNA from the grave environment into the bone, and contamination of the skeleton by DNA from the excavator and post-excavation handler, are all points to consider seriously; these are far from being resolved. As for dating and elemental analysis of human bone, molecular analysis is an area of study to be discussed by the archaeologist excavating the cemetery and the human bone specialist concerned. In a research orientated excavation, opportunities for a project involving these techniques may be considered. Early sampling of material by the specialist, on site and unwashed is needed for these techniques.

NB There is potential for studies of cremated bone in this area, where cremation has not been complete and small quantities of organic material may survive for analysis.

IV The Specialist

The study of human remains is the primary evidence for past human behaviour. Data generated from both human remains and their associated material culture provide a holistic view of the interaction of people with their environment. For example, study of both skeletal populations and their subsistence base has revealed a deterioration in health accompanying the transition from hunting and gathering to agriculture (eg see Cohen & Armelagos 1986) and the examination of human remains is essential for a multidisciplinary approach to diet (Gilbert & Mielke 1985). Pertinent questions about issues such as how the development of civilisation affected the health of societies can be answered directly by the analysis of human remains but only indirectly by associated material culture (Cohen 1989). The increasing number of people trained in the discipline of biological anthropology allows a more rigorous assessment of population data and this section demonstrates the potential of that data.

Having collected the context information ensure your human bone specialist gets it! Context sheets and plans were made to help post-excavation interpretation, and that includes the study of the human bone. The human bone specialist should be kept informed of new developments in post-excavation. One would expect the data recorded from the cemetery population to be used in conjunction with the rest of the archaeological data collected from the site to provide a wider interpretation. It is, therefore, preferable that there is constant liaison between the excavators and the specialist, eg if there is environmental evidence for diet from a site which may be relevant to the people buried in the cemetery, it is essential that this information reaches the human bone specialist. This is an important point with respect to cremation burials, where interpretation of pyre technology and ritual, much of which depends on the human bone specialist, may benefit from interaction with the animal bone specialist, environmentalist etc (see below). People working in isolation from each other will not produce the best results.

Finally, it is appropriate to consider the potential and actual information which the human bone specialist can provide the archaeologist. For more detailed discussions see Roberts *et al* (1989).

a) **Age:** the accuracy with which one can age and sex an individual depends on the quality and quantity of the skeletal remains. The most accurate results are obtained from a complete skeleton.

Age is much easier to assess in immature individuals. Methods consist of assessment of dental development and eruption, and long bone development and growth. These methods are based on the standard development of 'modern' populations; therefore, allowing for the differences in environmental constraints which may affect growth, for example diet, in archaeological populations is extremely difficult, if not impossible.

Once an individual has reached adulthood and all bones and teeth have fully developed, methods of ageing are based on degenerative changes to the body, which are determined by many factors, including sex, environmental determinants such as diet, and genetic factors. Many of the ageing methods have been developed on 'modern' populations and must be treated with caution when applied to archaeological populations. The most common and relatively reliable areas of the skeleton required to assess age in an adult are the teeth, pubic symphyses (front of the pelvis), the sacro-iliac joint (where the base of the spine articulates with the pelvis) and the ends of the ribs where they meet the sternum (breast bone). Despite the various of methods available for ageing adults, it is believed that the precision is poor. It may be that some adult skeletons are being under-aged by decades, whilst others are being overaged, and recent work on skeletal material of known age and sex supports this hypothesis. In view of this, most human bone specialists now use broad banded age categories rather than giving age in years eg 'young' (18-25yr), 'mature' (26-45yr) or 'older adult' (45yr +)

b) **Sex:** the skull, pelvis and the joint surfaces of some of the bones provide the most reliable areas of the skeleton for sexing an adult. The pelvic girdle (innominates and sacrum) is the most reliable. Immature skeletons have not developed the sexual characteristics used to assess the sex of adults (see Saunders 1992 for full discussion). Recent studies by Schutkowski (1993) have attained a 70% accuracy in sexing immature individuals using certain criteria and this methodology may be used more widely in the future. However, since immature bone recovery is often not as good as that for adults, application of the technique may be limited.

c) **Palaeodemography:** aims to provide basic biological and social information about human populations in the past, eg population structure, life expectancy and mortality, and fertility rates. Age and sex data are required to reproduce the palaeodemography of a population and given the problems with assessing the age of adults and the sex of immature individuals, in association with the possible under-representation of immature individuals (especially neonates-infants) in cemetery populations, there are limits to the application of what are essentially statistical techniques culled from population geography. In addition, to undertake the study of population dynamics, an exact time scale for the use of the cemetery would be needed, with recognisable site phasing in uniform blocks of time – not a luxury often obtained.

Whilst it may be possible to reconstruct life tables and estimate population size, in some instances even mortality curves for a cemetery, population 'dynamics' in the true sense is generally beyond our scope. Constraints upon the data must always be considered in discussion.

d) **Metrical data:** measurements of the bones of the skeleton are always included in a skeletal report and there are basic sets of measurements which most human bone specialists adhere to. These measurements are taken for a variety of reasons, including helping to determine the sex of the skeleton, to estimate stature or assess the relative shapes of bones between populations. It is important to have completely undamaged bones for measurement because reconstructing bones may introduce error.

e) **Non-metrical data:** there are a set of variables recordable in the skeleton known as non-metric traits (Saunders 1989). In the past, it was believed that these traits were all inherited. Whilst some modern studies have shown that some of these traits do run in families, there is no clear evidence to suggest that this is the case, and it is believed that many of them may be culturally induced. It is, therefore, inadvisable to use this data to infer family relationships within cemeteries until further, much more extensive, research has been undertaken into their aetiology.

f) **Palaeopathology:** this is the study of disease and trauma evident from pathological changes to the bone and teeth of skeletons, or soft tissues of better preserved bodies eg mummified material. It may reflect aspects such as health status, stress, diet, environment and living conditions, climate and hygiene. People who died from acute diseases would not have developed any bony changes; it is the part of the population who survived the acute stages of disease and developed the chronic form who can be identified skeletally. It is essential to have the whole skeleton available for examination as this will determine the amount of retrievable information. The burial context is also important eg a bog body will potentially generate more evidence for disease than a skeletonised body due to the former soft tissue preservation. It should also be remembered that pathological bones are inherently fragile and may disintegrate sooner in the ground, and lifting may cause them to fragment. Many individuals who may have severe pathological change and disfigurement evident in their skeletons may have died of a disease not recordable on the skeleton. For example, pneumonia probably caused the deaths of many people in the past, but this is a soft tissue (lung) disease and would not be revealed in the skeleton. Furthermore, it should be noted that the cause of death of any individual is usually impossible to ascertain unless there is irrefutable evidence of, for example, an unhealed head wound.

The age and sex profile of a population is particularly relevant with respect to palaeopathology, as the mortality of a group may reflect problems of health in that population. Age and sex are also important for interpreting disease, and it is interesting to note that evidence for disease on immature skeletons is rare relative to adults. It is likely that these individuals either died from an acute disease in such a short time that it did not allow development of bony changes or from a disease which does not affect the bone.

g) **Cremation technology and ritual:** with a cremation burial the specialist is not dealing purely with human bone. A cremation burial represents the remains of the cremation process, a technical procedure and ritual disposal of the dead. In post-excavation fragments of 'pyre goods' (as opposed to 'grave goods' in that they were on the pyre) of antler, bone, copper alloy or iron (depending on the period) may be retrieved from the burial. However, small fragments of cremated antler or bone pyre goods are often overlooked only to be retrieved by the experienced eye (McKinley 1989, forthcoming a, in press b). The presence of pyre goods may only be evident from coloured staining, eg blue/green copper alloy staining on bone, no goods having been included in the burial. Pyre goods such as copper alloy and glass may fuse to bone fragments, providing indications of the cremation ritual.

Many cremations contain cremated animal bone. This is relatively rare in the Bronze Age, more common in the later Iron Age/Romano-British period where up to 50% of cremations in a cemetery may contain some animal bone (McKinley forthcoming c), and large amounts of animal bone may be found in up to 50% of cremations in Anglo-Saxon cemeteries (McKinley 1989, forthcoming a, in press b). It is the human bone specialist who will recognise and retrieve this bone for the animal bone specialist to identify.

The efficiency of cremation should be determined by the specialist. The size of bone fragments may illustrate aspects of pyre technology and ritual, as may the quantity of bone included in the burial and the presence of other pyre debris (McKinley 1989, in press b).

There are many aspects of pyre technology and ritual which may only be determined by the human bone specialists work with the cremations. It is imperative in this field that the specialist is provided with full information. The best results are obtained by being able to work with other specialists.

Conclusion

Any archaeological excavation should receive detailed planning prior to its inception and it is not intended to suggest that cemetery sites are a special case. The text has been instigated by the lack of available published advice on dealing with human remains in an archaeological context and human bone specialist's need for a closer collaboration with archaeologists well before the skeletal material reaches the laboratory. The guidelines are intended to aid the archaeologist plan their strategy for the excavation of a cemetery site with the aim of avoiding actions which are detrimental to the preservation and analysis of past human populations. It is not meant to be the definitive guide because such a guide would extend beyond the scope of a technical paper. However, it will point people in the right direction for further information in the form of people or publications.

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IFA Technical Paper No 13

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