Analysing Human Remains

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(1. Title Slide)

Introduction

The aim of this talk is to tell you something about how one can analyse human bony remains in an archaeological context. Hopefully I'll be able to give you some practical advice about what to do when you find human bone, the sorts of simple post-excavational analysis that can be done without any specialised equipment, and what analyses can be performed for those with unlimited time and money – in other word, the ones that you send items away for. Obviously this is going to be something of a whistle-stop tour, but at least it should give any of you who are keen to become osteologists a starting point.

Identification

The first problem for the archaeologist in the field is to spot that you've (a) got bone, and (b) that it's human. **(2. Slide of skeleton *in situ* - Ipswich Blackfriars).** Usually this is not as difficult as it sounds. Human remains are most commonly buried deliberately and if you find human bone at all, you often find a fairly complete, articulated skeleton like this. Bone can be quite fragile so it may need to be excavated with a great deal of care, and obviously this sort of magnificent display is only possible for horizontal burials! **(3. Slide of darkened soil – Sutton Hoo).** Although bones preserve well, particularly in acid soils, bone can dissolve away completely surprisingly quickly, and leave very little trace (if any). A shadow of darkened soil can be all that left. However, in some situations, usually where there has been some post depositional movement (often the case in cave deposits), or where the bone accumulation is due to carnivore activity, you will find isolated human bones mixed with non-human bones and the situation here is rather harder. However, rather fortunately, in the UK there really are very few difficulties. **(4. Slide of chimp skeleton).** Yes, various human bones do indeed look a lot like there chimpanzee equivalents, but lets face it, unless you are excavating a early menagerie, you are not going to dig up a chimp in the UK, and if, for some bizarre reason, you did, you would be forgiven for not spotting it. One of the biggest clues for bone identification is overall size, and there just isn't a recent UK mammal with a similar body size to a human. Where this falls down is when you find fragments of bone, or bone from juveniles since obviously there are ages when human body size does overlap that of other mammals. Often, with this sort of material, the only way to make a positive identification is to compare the bone with a reference collection at a museum.

(5. Slide of labelled skeleton). The other aspect of identification is the identification of which bone you are dealing with. There are 206 individual bones in the human body (plus a few other small sesamoid bones found in tendons that may or may not be present), which sounds rather a lot. However, there are only about 31 names in this diagram, and that's probably all most people need to know. The two clues to working out which bone you are dealing with are: to mentally compare the bone you have just unearthed with those in your own body – you can work out how big arm bones should be by looking at your own arm bones; and to think about cuts of meat that you are familiar with. Ribs look rather like the bones you see in rack of lamb, scapulae in shoulder of mutton, and if you have rabbit stew, you can have a lot of fun picking out the little vertebrae. Many human bones are easy to identify. **(6. Slide of femur and femur flute from Thailand).** This slide shows a leg bone, and for interest also shows an artefact made from another leg bone. **(7. Slide of hand bones).** Hand bones like these are trickier, but as a group are easy to spot, and the finger bones particularly can be compared directly with your own hands. **(8. Slide of foot bones).** Foot bones are trickier because they are rather more irregularly shaped. **(9. Slide of sacrum).** There are a number of human bones that are very bizarrely shaped. This, of course, makes them very difficult to identify when you are unfamiliar with bones but very easy once you are more familiar. This is the sacrum which is a set of fused vertebrae where the spine attaches to the pelvis. **(10. Slide of sphenoid).** The winners in the strange bones stakes must go to the individual skull bones. This is an example of the sphenoid which is a complex 'wing-shaped' bone found in the centre of the skull. Hopefully, you'd never find one isolated like this, but rather it would be attached to the rest of the skull and therefore easy to identify. **(11. Slide of cremated bone).** This is probably an osteologists nightmare. This is an assemblage if sieved, cremated bone fragments. As you can imagine, trying to identify individual bones in a case like this is extremely difficult and time consuming. **(12. Slide of bone frequencies).** We don't find an equal mix of bones. Generally the larger bones are found more commonly. This may well be a feature of excavation since sieving the earth from around a skeleton always turns up a number of the smaller bones that would otherwise be missed. Dry sieving through a 0.5 mm mesh is essential to pick up smaller bones, and there are certainly some who advocate wet sieving everything through 1 mm mesh.

(13. Slide of teeth). The other bony items that are commonly found are teeth. With any luck these will be firmly inserted into the jawbone of the skull and hence easy to find and identify. However, dental enamel is very resilient stuff so it's quite common to find isolated teeth and these need to be identified. Once again, there is really nothing in the UK like a human tooth –

so if it looks at all like something in your own mouth, then it's probably human. If you can't see what your own teeth look like, then just ask a co-worker to show you theirs.

Now we've got our bones, what can we do with them?

Straightforward Analysis

I've entitled this section 'straightforward analysis' which might be something of a misnomer. It's really 'analysis that doesn't need an expensive or specialised equipment'. As my students will vouch, it's often anything but straightforward and often requires access to a great deal of reference material for comparison and a great deal of experience before it becomes second nature. However, it is definitely inexpensive and that's probably the reason for it's popularity in archaeology.

There are a number of pieces of information that can be gleaned from simple observation and measuring of skeletal remains. They are the sex of the individual, their stature (size), their age at death, possibly some information about their nutrition and disease status, lifestyle and cause of death, and possible some information about their race. One of the things that you often can't say very much about from just looking at the bones is how long they have been there. If you are unsure about the context, then you just might need to call the police (which means that if you want to dispose of a body, just bury it with a few bits of Roman pottery and everyone will be fooled!).

Sex

(14 Slide of a male and female growth). So, lets start with sex. This is a fairly essential item of information whether you are trying to reconstruct an individual or a population. Fortunately for us, the differences between men and women are more than skin deep. The primary sexual characteristics are indeed all soft-tissue based, but some of the secondary sexual characteristics do are preserved (it's interesting to note, that if you consider hair length to be sexual characteristic, then this is the commonest non-bony tissue to be preserved). There are two main differences between male and female skeletons. The first is size. Women are smaller than men in general, so that if you find an adult bone that is smaller than average, it's probably female, and if it's larger, it's probably male. The only caveat here is that the definition of average is population based. Asian peoples are shorter than Europeans, who themselves are shorter than Americans. This means that you do need to know what the average size is for your population which can be tricky. There is also quite a lot of overlap (short men and tall women), so that this method doesn't work well with individuals although it is perfectly acceptable for whole cemeteries. A better method (if you have the right bones) is to look for specific differences in the shape of particular bones regardless of their overall size. Even this is no better than 95% accurate – there's definitely a Russian shot-putter syndrome with women possessing morphologically male skeletons and *vis versa*. **(15. Slide of male and female pelvices).** Anyway, the best bones to look at are those that make up the pelvis. The differences are because the male pelvis does not need to cope with the passage of the baby's head during childbirth, hence as you can see, this area at the front called the sub-pubic angle is considerable wider in the female (over 90°). **(16. Slide of innominate bones).** There are even differences in the individual innominate bones that make up the pelvis. The large notch that you can see is where the sciatic nerve leaves the pelvis to enter the leg and it is much wider in the female (although not because the nerve is bigger, this is just a side-effect of the enlargement of the pelvic outlet). There are a number of other, smaller features and some numerical analysis techniques that can also be used.

(17. Slide of male and female skull). There are also specific, but much more subtle differences in the shape of male and female skulls. In this photograph, (1) shows that males have a more pronounced brow-ridge (though nothing like that found in Neanderthals!). (2) Shows how the mastoid process on the temporal bone and (3) the nuchal crest are much more prominent in males. These are attachment points for several important neck muscles and it is generally true that throughout the skeleton, muscle attachment points on the skeleton are likely to be more prominent in males. One of the problems with this is that the variation in muscle bulk is probably behaviourally dependent, so in a society where the manual workload is more evenly distributed between men and women will have more similar skeletons.

Unfortunately, none of the morphological sexing techniques works at all well on pre-pubertal skeletons. The differences really don't show up until after puberty along with all the other secondary sexual characteristics.

Age at Death

The next thing that we'd like to know is how old the individual was when they died. This is tremendously important when we are trying to estimate the life-expectancy of a population (obviously an important indicator of quality-of-life). **(18. Slide of infant skeleton).** Obviously, some specimens are easier than others. Infants are very easy to age. Growth is strongly correlated with age, as is dentition (remember that particular teeth appear at characteristic ages). The way that bones grow means that whilst they are growing the head of the bone (the epiphysis) is separated from the shaft of the bone (the diaphysis) by a layer of cartilage and once the bone stops growing, these two parts fuse. The pattern of this bony fusion is also reliably associated with age. **(19. Slide of X-ray of juvenile hand).** This slide shows x-rays of a 16 year-old and 3 year-old hand. They've been scaled to the same size, and you can identify that neither are adult because the epiphyses on the finger bones have not fused and that the one with fewer wrist bones showing up as starting to ossify is the younger one. This technique is commonly used to diagnose growth abnormalities in children because the bony fusion and the conversion of early, cartilage models of bone into calcified bone can be detected by X-ray.

Once we get to adults, the whole problem is much harder. There are plenty of skeletal changes associated with old age – arthritic changes, loss of teeth, fusion of separate bones (especially in the skull) – but the actual age that they occur is very variable. There are a whole host of methods that have been tried to get around this, but none of them are entirely satisfactory and they all require a great deal of familiarity with how bones look. I shall talk about a couple, and I will show slides, but I suspect you will find it hard to see the differences. **(20. Slide of pubic symphyses).** The first is pubic symphysis. This is the join between the left and right innominate bones at the front, in the midline, just behind the zip on a pair of trousers. In a young adult, the surface of this joint is described as 'billowy' since it shows a pattern of almost horizontal waves. As you approach middle age, the surface becomes smoother and a rim starts to form. In old age, the rim breaks down and the surface becomes pitted and porous. In practice, what you do is compare your unknown bone with a reference set. This is reasonably easy if you have a collection of bones to compare it with. It's much harder if all you have is diagrams from various books. You can do something very similar with the costochondral junction which is the joint between the end of a rib and the breast-bone, but I would say that it's even trickier.

(21. Slide of aged jaws). Another approach is to look at teeth. Just like in horses! As I said before, the pattern of tooth eruption gives a very good age estimate – except for the wisdom teeth which quite often never appear – and loss off teeth indicates old age. The difficulty again is that there is very little variation among adults. However, you can estimate age more precisely in specific populations by looking at the degree of tooth wear. **(22. Slide of dental wear – Medieval population).** Obviously, this is again behaviour dependent. People who tend to eat unwashed vegetables have increased wear due to the grit in the food. Groups who use their teeth as tools (for example in leather working or brewing) can often have very specific wear patterns. However, with a reasonably well categorised population, this can be a useful method of estimating age and is certainly rather easier to judge.

Stature

Bigger people have bigger bones and teeth. It's obvious, and the relationship is pretty good. It's better to use long bones for this sort of estimate because they are more directly related to height and therefore more reliable, but you can work out curves like this for any bone, or even any fragment of bone you choose. Just don't expect an estimated height based on the dimensions of the first premolar tooth to be quite as convincing as one taken by measuring the articulated skeleton in the ground.

Lifestyle Traits

I'll now move on to a miscellaneous set of features that you can pick out that tell us something about the lifestyle of the individual. This includes such things as evidence of disease or injury, nutritional status and sometimes even cause of death. Cause of death, can be very tricky since even when there is clear evidence of a pathological condition, it may not be clear that this caused death. **(23. Slide of decapitation – 4th Century, Stanwick, England).** Clearly this is evidence of beheading. Natural taphonomic processes would not move just the skull like this. But whether it occurred before or after death is something we cannot tell although it would clearly be a fatal wound. There are plenty of diseases that leave characteristic marks on the skeleton. These include classics such as syphilis, tuberculosis and leprosy. We also need to include osteoarthritis and various cancerous conditions such as osteosarcomas. There are generally specific features of these lesions that can be used for identification. **(24. Slide of TB vertebrae).** Tuberculosis classically causes the disintegration and fusion of the bodies of the lumbar vertebrae. Recently, TB has also been diagnosed by detecting the DNA of the tuberculosis bacterium. **(25. Slide of osteoarthritic vertebra).** This slide shows the appearance of osteoarthritic vertebra – there is a severe roughening of the bony surface (especially the articular surfaces) but no disintegration. **(26. Slide of syphilitic skull).** Tertiary syphilis commonly causes lesions in bones, especially in the cranium. These need to be distinguished from man-made holes in the head – which they can be because they show signs of having been eroded round the edges. **(27. Slide of musket ball wound).** This is a musket ball injury which can be identified by the impact fracturing around the edge. **(28. Slide of trepanned skull).** This is the result of the surgical procedure known as trepanning where bone is removed from the vault of the skull. This is actually quite an ancient operation used to cure everything from headaches to epilepsy. It can be identified in this case by the regularity of the hole and the saw marks at the edges. Rarely, you see signs of healing which suggest that the patient actually survived for sometime after the operation. **(29. Slide of sabre cut).** Other injuries can also be identified such as this sabre cut. **(30. Slide of healed fracture).** You often see evidence of previously healed fractures in long bones such as this tibia. Fractures can heal with no sign if they are set properly, but poorly set fractures result in this sort of distortion and uneven bony deposition.

(31. Slide of Harris lines). Nutrition has a profound effect on the growth of bones whether in terms of absolute size or defects. The feature shown here is known as a Harris line and is an indication of a period of poor nutrition during growth. **(32. Slide of porous bone).** Normally, the bone around the orbits is smooth. However, in this case we can see signs of increased porosity which is once again linked to poor nutrition. The porosity is due to the reabsorption of bone minerals. **(33. Slide of woven bone).** Finally, in this bone you can see signs of newly laid down woven bone. This would be normal in a very young child, but in this adult bone it is a sign of either injury or malnutrition. **(34. Slide of enamel hypoplasia).** Similar effects can sometimes be seen in the teeth. This is a condition known as enamel hypoplasia. Once again, the mineral component has either been reabsorbed or was never laid down properly in the first place and is a sign of malnutrition. **(35. Slide of rickets).** This shows what happens to the bones of someone who has a vitamin D deficiency. The condition is known as rickets and can either be due to dietary deficiency or lack of sunlight since vitamin D can be synthesised in the skin if exposed to sufficient UV radiation. Vitamin D synthesis has been postulated as one of the reasons why skin colour varies regionally. People living in northern climates need to maximise the penetration of sunlight into their bodies to allow vitamin D synthesis, whereas people living in sunnier climates have skin pigments to block UV radiation and reduce its harmful effects to the skin.

(36. Slide of Squatting Facet). Occasionally you get direct evidence of activity as shown by this slide of a squatting facet at the distal end of the tibia. Other examples are variations in bone cross-section area in people whose activity pattern is such that one arm works much harder than another. The best example of this is professional tennis players.

Race

There is a degree of dispute about the biological reality of different races. However, it is certainly true that certain populations have morphological differences in their skeletons. **(37. Slide showing Negroid, Caucasoid and Mongoloid skulls).** How characteristic particular features are and to what level of discrimination you can go is open to debate, but most anthropologists would agree on these three groupings. Once again, the differences are quite subtle, but the information obtained in terms of mapping migrations of populations is very useful. This slide shows some of the features that can be seen on a front view of the skull. None of the individual features guarantee a diagnosis, but taken together, they can be used to guess a likely racial background. There are also non-metric traits - that is qualitative differences in bones - whose frequencies vary in different populations and family groups. **(38. Slide of ossicles).** These are ossicles - small, extra skull bones that are sometimes found along the joins between the individual skull bones. **(39. Slide of metopic suture).** This picture shows a skull where there are two bones making up the forehead region rather than the normal single bone. There are no functional significances for these variations, but with a large enough collection of bones from a population (a cemetery for example), by measuring the frequency of occurrence of these differences we can say something about the possible relatedness to other populations.

Advanced Methods

I am now briefly going to say something about some of the other things that can be done with bones. These require access to a laboratory and specialised equipment but can provide a great deal of extra information.

Dating

The most important thing that you can do in the laboratory (hopefully) is date the bone. Bone is often used for carbon dating since it usually still has traces of collagen fibres inside the mineral matrix.

Diet

(40. Slide of C3/C4). Another thing we can do is to measure the chemical composition of the bone. By making a number of assumptions about how this composition has been changed by the environment that the bone has been preserved in, we can estimate the chemical composition of the original bone and this has been shown to depend on the sort of diet that the individual ate. This isn't very specific, but for example, by looking at the ratio of various isotopes of nitrogen and carbon, we can identify the broad type of the major protein source in the diet. As you can see from this diagram, particular foodstuffs have characteristic ^{13}C and ^{15}N levels, and if a skeleton is found to have a similar level, then we can guess the major component of the diet. C3 and C4 plants use different metabolic pathways which leads to these different stable isotope levels. Most plants are C3; C4 plants include maize so this has been very useful in looking at the spread of staple food crops.

DNA

(41. Slide of DNA). Another very important development is Ancient DNA (aDNA). This is where we extract the fragments of DNA left (hopefully) in the bone using the same techniques as forensic scientists. **(42. Slide of X/Y chromasome gel).** This DNA can then be subject to a number of standard genetic tests which can give us, for example, reliable information about sex getting around the Russian shot-putter problem and being effective on juvenile skeletons. This slide shows a test for the presence of X and Y chromasomes in a Egyptian mummy. The presence of an X shows that the experiment worked and the lack of a Y indicates that this individual was female. Another use has been in identifying the sex of a number of child skeletons found in a Roman sewer beneath a brothel to see whether sex-preferential infanticide was occurring. **(43. Slide of DNA fingerprint).** We can also identify individual kinship in much the same way that DNA fingerprinting is used for modern day paternity testing. In this slide you can see that the child's DNA fingerprint is made up of bands inherited from both parents. We can also identify which bones belong to which individuals in mixed bone assemblages. aDNA techniques are becoming very important (and are actually relatively cheap to carry out so they are becoming more widespread). The thing to remember is that it is very easy for specimens to become contaminated with modern DNA which means that you end up measuring the relatedness of the excavation team rather than the bones. This means that specimens destined for aDNA analysis should be excavated with more than normal care, preferably with gloves, a face mask and a shower cap (dandruff is a major contaminant). They should not be handled and placed immediately into new plastic bag.

There have been some outrageous claims about what can be done with aDNA – extracting it from million-year old stone tools or whatever. Current thought is that DNA doesn't survive millions of years. Tens of thousands at most. Added to that, it turns out that amber is relatively poor at preserving DNA because it's quite water permeable – so we are not going to bring back any dinosaurs I'm afraid. Still, there's a reasonable chance that any well-preserved post-glacial bone may well (or may well not) contain DNA so it's often worth having a shot.

Conclusion

Well, I hope I've inspired you all to go out and buy several text books on osteology, or at the very least shown that the human skeleton is important to the archaeologist and can give us plenty of information.

Further reading

The archaeology of human bones. Simon Mays.
The anatomy and biology of the human skeleton. Gentry Steele and Claud Bramblett.