Estimating Adult Age: Auricular Surface Morphology

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Abstract: The auricular surface is located on the os coxae (pelvis) and forms part of the sacro-iliac joint. Changes in appearance of the auricular surface have been used to estimate adult age-at-death. Two main methods are used in bioarcheology: the Lovejoy method and the Buckberry-Chamberlain (revised auricular surface) method. As with many age estimation methods, neither auricular surface method reaches the gold standard of being both accurate and precise, however the age-related changes of the auricular surface do extend into the later decades of life.

Key Words: age estimation; aging; adult; auricular surface; paleodemography; demography; bioarcheology

The auricular surface is located on the posterior portion of the ilium and has been used to estimate adult age-at-death since 1985. Various different age estimation methods have been developed and applied to archeological populations (see also saseas0222, saseas0223, and saseas0224). While the auricular surface may not always be the first choice for age estimation, it is often utilized because it is robust, surviving the burial environment much more often than the fragile pubic symphysis < saseas0223>, and because age-related changes continue into the later decades of life. It is likely that the anatomy of the sacro-iliac joint influences age-related changes.

The auricular surfaces of the ilium are part of the sacroiliac joints (SIJ) between the sacrum and the left and right ossa coxae (pelvic bones). The joint surfaces are described as C, L or ear-shaped and their size and shape are variable between individuals and between the left and right sides. The SIJ is a complex joint which allows a small amount of movement (although the degree of movement is debated) and is stabilized by ligaments. In the final stages of pregnancy, hormones allow the ligaments to relax, allowing for greater movement of the SIJ during childbirth (Vleeming et al. 2012). Despite this few sex-related differences in the rate of ageing have been reported. The inferior portion of the joint is synovial whereas the superior portion of the joint is more fibrous. On the sacral side, the joint surface is covered with a thick layer of hyaline cartilage whereas on the iliac side it is covered with a thin layer of fibrocartilage in childhood which progressively changes to hyaline cartilage with maturation (Vleeming et al. 2012). Similar age-related changes are not observed on the sacral side of the joint; this is probably due to the differences in anatomy. Fusion of the SIJ is seen in a small percentage of older individuals (usually over 50 years of age and more commonly in males) and is associated with some pathological conditions, such as ankylosing spondylitis.

The first formal method developed to estimate age from the auricular surface was by Lovejoy and colleagues (1985) based on observations of the Libben population (archeological) and the Todd Collection (known-age). They described typical features of auricular surfaces which were grouped into six five-year, one ten-year, and a final, open-ended age groups. These narrow age-ranges do not appear to reflect the range in age variation seen for each of the auricular surface stages (Osborne, Simmons, and Nawrocki 2004) and have found to have low levels of accuracy (based on the number of individuals that do not fall into the age ranges). Indeed, it was noted in the original paper that the individuals selected for photography often fell outside their modal age group (Lovejoy et al. 1985, 21, 23). Key features associated with the ageing process of the surface itself were billows (which are transversely organized and reduce in depth to striae), microporosity and macroporosity (which appear and increase with increasing age), grain (the joint surface becomes more coarse with increasing age), and density (which referred to the surface appearance of the bone and appears to replace coarsely granular bone). These are associated with changes to the apex (the edge of the joint adjacent to the end of the arcuate line) and the retroauricular area (located posterior to the joint surface). Changes in the latter two areas were referred to as increasing "activity" by Lovejoy and colleagues.

In 2002, Buckberry and Chamberlain (2002) published the "revised auricular surface" method, which recorded five features of the surface (transverse organization, surface texture, microporosity, macroporosity and apical changes) independently before combining them as a composite score to estimate age. The features utilized were based on those of Lovejoy and colleagues and were quantified by assessing how much (as a percentage) or which area (neither, one or both demifaces) of the auricular surface was affected. Age was presented as 100% ranges and mean ages for seven auricular surface stages. The age ranges reflect variation in auricular surface appearance and as a result are very wide. While this increases accuracy compared to the Lovejoy method, these ranges are imprecise. The revised method included a Bayesian analysis of the data, assuming a uniform prior probability of age, and thus removing the biases introduced by the reference sample (Christ Church, Spitalfields), which is skewed towards older ages.

Tests of the methods have shown that the auricular surface seems to vary little between the two sexes and different ancestry groups. Population level differences are observed, but this probably partially a result of the comparison of known age against reported mean age estimates (which reflect the age structure of the reference sample); unless the reference sample and the target population have a similar age-at-death structure high levels of bias and inaccuracy will be evident. Bayesian statistics have been used to develop paleodemographic profiles (see also saseas0431) that are not influenced by the age structure of the reference sample and have been used successfully to investigate catastrophic mortality during the Back Death and to compare archeological populations in Japan (for example). Future research should address more robust statistical methodologies for combining age-related data and presenting the age of an individual.

Other methods of age estimation that include the auricular surface have been published, but appear to be used less frequently. The auricular surface was included in Transition Analysis <saseas0224>. In this method, auricular surface traits are particularly useful for estimating the age of older individuals, and the trait "posterior iliac exostoses" specifically has been noted as a trait of old age. Attempts to apply auricular surface age estimation to 3D images have had limited success and it is likely that 3D data-specific techniques would need to be developed, as many auricular surface features (grain, striae, microporosity) are hard to capture using laser scans or CT scans.

See Also

saseas0222
saseas0223
saseas0224
saseas0431

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Further Readings

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