

Osteoporotic Bone Loss in an Illinois Hopewell Population

ANTHONY J. PERZIGIAN

Department of Anthropology
University of Cincinnati, Cincinnati, Ohio

Abstract

The effects of the aging process on the human skeleton were studied. Intact radii from males and females ranging in age from 20 to 70 years were sampled from an Illinois Hopewell site. The bone mineral content of each radius was measured at two sites by a photon absorptiometric method. Both males and females exhibited osteoporotic bone loss as was shown when bone mineral was plotted against age yielding negative slopes. Regression slope coefficients were larger for males, though not significantly so statistically. Trabecular bone loss was greater than cortical loss for both males and females. In modern populations females usually suffer greater bone loss, and trabecular tissue, as opposed to cortical tissue, exhibits greater loss with age. The Illinois Hopewell population investigated here resembles modern populations in osteoporotic processes.

This study focuses on the results of the aging process in a Classic Illinois Hopewell population. The skeletal materials represent burials found at the Klunk site in Calhoun County, Illinois. This is the largest sample of an Illinois Hopewell population in existence (2). Adult Hopewellians, like modern individuals, experienced with aging a gradual rarefaction of bone, *i.e.*, osteoporosis. This disease or disorder evidences itself as a softening and increased radiolucency of bone due to a loss of bone mineral. Some authors attribute the ubiquity of osteoporosis as a normal concomitant of aging. Others, recognizing extreme degrees of bone degeneration in presenile and senile individuals, consider osteoporosis to be a pathology. A cross-sectional study was undertaken on the Hopewellian skeletal population to describe age-associated changes in the radius and to compare the results with those from modern populations.

Materials and Methods

Only well-preserved, intact radii were used. The sample had 45 males and 40 females ranging in physiological age from 20 to 70. Radii which displayed any pathology were not used. The bone mineral content of each radius was consistently measured at two sites: a cortical or compact bone site at a point $\frac{1}{3}$ the shaft length as measured from the styloid process and a trabecular or spongy bone site, at a point $\frac{1}{5}$ the distance from the styloid process. A photon absorptiometric technique developed by Cameron (1) was employed to measure the bone mineral content. A monoenergetic photon beam from a low energy radionuclide, Iodine-125, was passed across the width of the bone. Changes of transmittance, which are directly proportional to the bone mineral mass in the scan path, were measured with a scintillation detector-pulse height analyzer system (3). Data from each scan or measurement were transferred to paper tape by means of an eight channel Tally Paper Tape Punch. An IBM Tape

to Card Converter, Model 047, transferred the data to the regular 80 column cards. All calculations and statistical analyses were performed by an IBM Digital Computer, Model 7040.

Results

The dependent variable in this study is the bone mineral content (BMC) of the radius, and the independent variables are age and width of bone at the site of measurement. For each sex, the BMC of both the cortical and trabecular sites was plotted against age. Linear regression equations were calculated for each plot. The F-test or analysis-of-variance established that each regression of BMC on age was significantly linear. The regression slope coefficients in each case were negative indicating a progressive loss of bone mineral with age in both trabecular and cortical tissues of the male and female Hopewellian radii.

In modern populations trabecular mineral loss is greater than cortical loss (3). The popular t-test was used to compare the trabecular and cortical regression slope coefficients. In both males and females no statistically significant difference was found; however, for both sexes the trabecular coefficient was larger (more negative) than the cortical coefficient. This points to the similarity in aging patterns between modern and prehistoric populations.

Most clinical studies report that post-menopausal women experience the highest rates of osteoporotic bone loss. Males do not normally begin losing bone until well into their seventh decade. The trabecular and cortical plots did not show an accelerated rate of loss among the older females since the total sample is probably too small. When the regression coefficients of the males are compared to those of the females by means of a t-test, no significant difference was found. Surprisingly, however, the male cortical and trabecular slope coefficients were larger (more negative) than the female coefficients, indicating that, for this one sample, males had lost slightly more bone with age than females. This departure from modern standards may be due to inherent limitations imposed by any archaeological sample.

Discussion

The employment of archaeological samples as media for bone biodynamic investigation introduces certain limitations which should be mentioned. For example, adequate sampling may be made difficult by certain cultural practices. The mound burial customs of the Hopewell culture are well known to students of North American prehistory. The most elaborate burials in the mounds were the log tombs which may have been lined with fabrics. Perino (5) indicates the possibility that social position may have dictated the place and type of one's interment. This may suggest the possibility that occupants of the tombs may have been a privileged class, which enjoyed a better diet, better shelter and better medicinal care attendant with their rank. These are important variables since diet and life style

may affect the aging process. Also, the possibility exists that certain illnesses may have plagued prehistoric populations and that those individuals who were afflicted required post-mortem isolation and were interred in log tombs or graves. These illnesses may have interfered with bone metabolism.

Stewart (6) emphasizes that the existence of skeletons means possible death by some pathology, which could seriously skew data on aging changes. For example, a cross-sectional biodynamic study conducted on a skeletal population may not reflect actual trends, for those skeletons aged 30 at time of death may not represent those healthy 30-year olds who lived to be 40 or 50. This study concerns itself specifically with the effects of aging on skeletal density. However, a variety of pathoses may look the same in a skeleton such that some rarefying disease may be mistaken for the aging process. Morse (4) mentions the pluricausality of osteoporosis other than by aging such as disuse, malnutrition (protein deficiency), endocrine imbalance, anemia and any chronic or debilitating disease that may result in reduced physical activity. Since no medical history is available for the sampled individuals, the investigator is forced to treat all materials equally except where gross or recognizable pathology exists.

Life expectancy in aboriginal America was significantly shorter than it is today. Not surprisingly, archaeological samples have proportionately fewer individuals of advanced age. It is especially difficult to discover aging trends in the fifth and sixth decades. Compounding the sampling problem, too, is the very process under investigation. With advanced aging, skeletons become progressively de-mineralized and structurally weakened. One might reasonably hypothesize that the older the individual is at the time of death the poorer the state of preservation with all things being equal.

The advantages of using archaeological samples do outweigh the limitations. If strict care is taken during excavation and cultural association is established, skeletal populations provide investigators homogeneous samples to work with. Clinical investigations of age-associated pathologies in modern populations are made difficult for it is virtually impossible to simultaneously control for diet, occupation, social class much less for genetic background. With the archaeological sample one is provided a breeding population that has inhabited an area possibly for centuries and therefore represents a genetic and cultural continuum through time. Each individual in the population was influenced by his environment in essentially the same way. In aboriginal America, dietary and occupational variety was severely restricted. With two or more skeletal populations, each genetically and culturally homogeneous, one can measure a certain variable such as bone mineral content and attribute any population differences to independent variables such as ecological factors or genetics.

Conclusions

1) An Illinois Hopewell population has been shown to have age-associated osteoporotic tendencies similar to those of modern populations. The rate of mineral loss in the radii was greater in trabecular bone than in cortical bone, and males evidenced slightly more mineral loss with age than females.

2) Certain limitations are everpresent when studying an archaeological sample. Apparent aging differences between Hopewell and modern populations may be explained by these limitations.

3) Archaeological samples provide investigators unique opportunities to investigate the biodynamics of skeletal aging.

Acknowledgments

I would like to thank Dr. G. K. Neumann of Indiana University who provided skeletal materials and guidance; Dr. C. Conrad Johnston of the Indiana University Medical Center who provided access to photon absorptiometric apparatus; Dr. David M. Smith of the Medical Center who helped with technical aspects; and Dr. Pao-Lo Yu of the Medical Center for help with data analysis.

Literature Cited

1. CAMERON, J. R., and J. SORENSON. 1963. Measurement of bone mineral in vivo: An improved method. *Science* 142:230.
2. HUNTER, K. B., and G. K. NEUMANN. 1969. Origins and racial affiliations of the Illinois Hopewell Indians. *Proc. Indiana Acad. Sci.* 79:62-64.
3. JOHNSTON, C. C., D. M. SMITH, PAO-LO YU and W. P. DEISS. 1968. In vivo measurement of bone mass in the radius. *Metabolism* 17:1140-1153.
4. MORSE, D. 1969. Ancient Disease in the Midwest. Rep. of Invest. No. 15. Ill. State Mus., Springfield. 3 p.
5. PERINO, G. H. 1968. The Pete Klunk mound group, Calhoun County, Illinois: The Archaic and Hopewell occupations. *In* Hopewell and Woodland Site Archaeology in Illinois. Bull. 6. Ill. Archaeol. Surv.
6. STEWART, T. D. 1969. The effects of pathology on skeletal populations. *Amer. J. Phys. Anthro.* 30:443-449.

