

THE ANTIQUITY OF OSTEOPOROSIS

L. JÓZSA

Department of Morphology, National Institute of Traumatology, H-1430 Budapest, P.O.B. 21, Hungary.

(Received: December 10, 1996)

Abstract

Osteoporosis has its origins in antiquity. Age-related bone loss has been observed in archaic and Medieval skeletons (especially females). Osteoporosis was a rare alteration before the 19th century. The consequences of osteoporosis (proximal femur end fractures, radius fractures and vertebral fractures) are very rare both in mummies and in archaic skeletal material.

Key words: osteoporosis, osteoporotic fractures, incidence, mummies, skeletons.

Introduction

The term osteoporosis was employed by pathologists in the mid-19th century and was clearly distinguished from osteomalacia. But does this mean that osteoporosis did not exist before? Paleopathologic examinations of ancient skeletons seem to indicate that osteoporotic fractures (vertebral fractures, femur proximal end fractures, etc.) were very rare.

We cannot assess the exact incidence or the age of development of osteoporosis by looking into the past. The aim of this brief overview is to ascertain whether osteoporosis has existed for centuries or millennia.

In osteoporosis research, bone density can be determined accurately and precisely by a large variety of methods, including qualitative and quantitative radiography (roentgenological examination, CT scan, ultrasound scan, etc.), densitometry (single photon absorptiometry=SPA, dual photon absorptiometry=DPA, and dual energy X-ray absorptiometry=DXA), histomorphometry and biochemical assessments. The most frequent methods in paleopathology are radiography and histomorphometry. In addition to measurements of bone mineral content and trabecular bone density, the determination of true bone geometry and architecture should be included in paleopathologic studies.

Prehistoric times

The postcranial bone remains of early hominids are extremely rare (for example: *Homo habilis* 14 limbs, WOOD, 1992). This small material is completely insufficient for an estimation of the occurrence of osteoporosis, but the radiological examinations of the Australopithecinae show no structural alterations in the bones (LEAKEY et al., 1995; SUSMAN, 1994).

The Neanderthals lived between 100,000 and 35,000 BP in Europe and Western Asia. Their limb bones differed from those of modern humans only in their tendency to be more robust. The cortical thickness of Neanderthal bones was 1.5 to 2.0 times greater (especially in the bones of the lower limbs) than in recent human samples. In addition, the trabecular bone density of the Neanderthals was higher than that of modern humans. The robusticity index of the Neanderthals was 30 to 60% greater in all bones of the lower limbs than in modern humans. We know of no signs of osteoporosis described for the Neanderthals (TRINKAUS, 1983; TRINKAUS and HOWELLS, 1979; TRINKAUS and ZIMMERMAN, 1982).

KNEISSEL et al. (1994) studied cancellous bone changes in 18 individuals from the early Bronze Age (4000 BP) from Lower Austria. They demonstrated that the loss of quantity in the cancellous bone occurred in females between the ages of 40 and 60 years. In contrast, BELL et al. (1996) found no age or sex differences in the amounts of cortical bones in archeological material. FRIGO et al. (1996) found differences in bone density between women and men in the early Bronze Age (4200-3600 BP).

Osteoporosis in historic times

The radiological and DPX examinations by EKENMAN et al. (1995) revealed a higher bone density in the lower extremities in a population from 1300-1530 AD from Stockholm than in modern humans. There was no decrease in bone density in the older group as compared to the younger. LEES et al. (1993 and 1995) found no significant bone loss in women over a period of two centuries, whereas marked gender differences were detected by DXA.

We have made a radiologic examination of 341 adult skeletons from the 10th-12th centuries. The frequency of vertebral and femoral osteoporosis was 7.0% among men over 61 years, and 16.6% among senile females (JÓZSA and PAP, 1996). No osteoporotic fractures were found in the vertebrae, femora, tibiae and pelvic bones. FARKAS et al. (1993) found only one case of osteoporosis among 294 adult skeletons from the 10th-12th centuries. LUZSA et al. (1988) radiographically detected only one case of osteoporosis, in a 39-year-old female, among 15 Hungarian royal skeletons. Among the Medieval Hungarian population, the incidence of osteoporosis was very low and osteoporotic fractures were extremely rare (FARKAS et al., 1993; JÓZSA, 1996; JÓZSA and PAP, 1996; LUZSA, 1988; PAP and SUSA, 1986; etc.). In the Hungarian

paleopathological literature, MOLNÁR et al. (1996) first described one case of cervical and one case of intertrochanteric fracture and severe osteoporosis in senile females, among 286 skeletons from the 10th-12th centuries. We have determined the bone mineral content and bone mineral density by SPA on 110 radius samples from the 10th-12th centuries. No progressive osteoporosis was found in this material (DÓCZI et al., in preparation). The osteodensity and bone mineral content were higher in all age groups in Medieval bones than in modern humans.

REIMERS et al. (1988) histometrically determined the trabecular bone mass of 65 skeletons of nonsenile prehispanic (before 1495) inhabitants of Grand Canaria. The authors found that 29% of the prehispanic population of Grand Canaria had osteoporosis. BURR et al. (1990) reported that the osteonal wall thickness and the dimensions of the osteons did not change with age in prehistoric Pecos Indians. In contrast, GUNNES-HEY (1985) found age-related cortical bone loss among prehistoric Koniag Eskimos. PFEIFFER and KING (1983) demonstrated a strong dependency between diet and cortical bone mass among prehistoric Iroquoians. It is well confirmed that the bone mass loss increases with age in prehistoric populations, but this does not necessarily mean osteoporosis (BEAR et al., 1990; ERICKSEN, 1976; GUNNES-HEY, 1985; VAN-GREVEN et al., 1969).

In some bone pathologies, such as infection, rheumatic diseases and malignant tumors, severe osteoporosis could not be detected in skeletons (GUNNES-HEY, 1980; KRAMAR et al., 1990; LESTER and SHAPIRO, 1968; THOULD and THOULD, 1983; WELLS, 1962, 1963; etc.). However, severe osteoporosis was found in the skeleton of a young female displaying premature senescence (HAHN and CZARNETZKI, 1980).

In summary: the data in the anthropological and paleopathological literature suggest that osteoporosis and especially its consequences (i.e. osteoporotic fractures) were rare before the 19th century.

Osteoporotic fractures

The literature (JÓZSA et al., 1996) details the autopsy protocols (ALDRED and SANDISON, 1962; BORN, 1959; BOURKE et al., 1971; BROTHWELL et al., 1969; COCKBURN et al., 1975; ELLIOT-SMITH and DAWSON, 1924; EL-NAJJAR et al., 1980; HENN, 1993; JÓZSA et al., 1996; KUO-LIANG et al., 1982; LEWIN, 1991; MOODIE, 1931; RUFFER, 1921; SHAW, 1938; SMITH, 1908; WALDRON, 1990; WEI, 1973; WILLIAMS, 1927; WOOD-JONES, 1908; WU, 1981), and roentgenographic, CT and magnetic resonance examinations on more than 3000 Egyptian, Chinese, South-American, Eskimo, Aleutian, Canarian and European mummies (AHLSTRÖM et al., 1978; BRAUNSTEIN et al., 1988; ENDES and VARGHA, 1988; GRAY, 1967, 1973; HARRIS and WENTE, 1980; HODLER et al., 1990; HÜBENER and PAHL, 1981; LEWIN, 1978; LEWIN et al., 1990; MARX and D'AURIA, 1988; MOODIE, 1931; PIEPERBRINK et al., 1986). No osteoporosis or osteoporotic fractures were mentioned among the South-American, Aleutian, Eskimo, Canarian, Chinese and European mummies. Among the Egyptian

mummies (over 1800 cases) 6 cases of cervical and 2 cases of intertrochanteric femur fractures were detected, and in addition one case of pathological fracture of trochanteric region due to malignancy. In the literature, we found no osteoporotic (distal) radius fracture and few vertebral fractures.

In skeletal material, PALES (1930) first reported one cervical and two intertrochanteric fractures from the late Roman period. Later, about 20 cases of fractures of the proximal femur end were described (BENNIKE et al., 1985; BERG, 1972; HAMADA and RIDA, 1972; HUSSEIN, 1950; JÓZSA et al., 1996; MOLNÁR et al., 1996; WELLS, 1964).

The paleopathological, paleoradiological and paleohistological examinations suggest that neither osteoporosis nor osteoporotic fractures were frequent among prehistoric and historic populations.

References

- AHLSTRÖM, C. G., HAKANSSON, S. and DALIN, T. (1978): The mummy at the Museum Stobaeum in Lund. - *Sydsvenska medicinhistoriska sällskapets årsskrift* 15, 17-42.
- ALDRED, C. and SANDISON, A. T. (1962): The pharaoh Akhenatos, a problem in Egyptian pathology. - *Bull. Med. Hist.* 34, 293-316.
- APPELBOOM, T. and BODY, J. J. (1993): The antiquity of osteoporosis. More questions than answers. - *Calcif. Tissue Int.* 53, 567-569.
- BELL, K. L., LOVERIDGE, N., KNEISSEL, M. et al. (1996): Circumferential distribution of bone within the femoral neck cortex in an archeological and present-day population (Abstr.). - *Bone* 18, Suppl. 196.
- BENNIKE, P. (1985): Paleopathology of Danish skeletons. - Munksgaard, Copenhagen.
- BERG, E. (1972): Paleopathology: Bone lesions in ancient peoples. - *Clin. Orthop. Rel. Res.* 82, 263-267.
- BOURKE, J. B. (1971): The paleopathology of the vertebral column in ancient Egypt and Nubia. - *Med. Hist.* 5, 363-380.
- BRAUNSTEIN, E. M., WHITE, S. J., RUSSEL, W. et al. (1988): Paleoradiologic evaluation of the Egyptian royal mummies. - *Skelet. Radiol.* 17, 348-352.
- BROTHWELL, D. and SANDISON, A. T. (1967): Diseases in antiquity. - Thomas, Springfield.
- BROTHWELL, D., SANDISON, A. T. and GRAY, P. H. K. (1969): Human biological observations on a Gauchan mummy with anthracosis. - *Am. J. Phys. Anthropol.* 30, 338-347.
- BURR, D. B., RUFF, C. B. and THOMPSON, D. D. (1990): Patterns of skeletal histologic change through time: Comparison of an archaic native American population with modern populations. - *Anat. Rec.* 226, 307-310.
- CAMPILLO, D. and VIVES, E. (1985-86): Exposición de nuestra experiencia paleopatológica de época medieval. - *Dynamis* 5, 31-58.
- COCKBURN, A., BARRACO, R. A., REYMAN, T. A. et al. (1975): Autopsy of an Egyptian mummy. - *Science* 187, 1155-1160.
- DÓCZI, J., PAP, I. and JÓZSA L. (in preparation): Bone mineral density of radius in Medieval skeletons.
- EKENMAN, I., ERIKSSON, S. A. V. and LINDGREN, J. H. (1995): Bone density in Medieval skeletons. - *Calcif. Tissue Int.* 56, 355-358.
- ELLIOT-SMITH, G. and DAWSON, W. R. (1924): Egyptian mummies. - Dial Press, New York.
- EL-NAJJAR, M. Y., BENITES, J., FRY, G., et al. (1980): Autopsies on two native American mummies. - *Am. J. Phys. Anthropol.* 53, 197-202.
- ENDES, J. and VARGHA, Gy. (1988): Egyiptomi múmiák röntgenvizsgálata. - *M. Radiológia* 62, 27-38.
- ERICKSEN, M. F. (1976): Cortical bone loss with age in three native American populations. - *Am. J. Phys. Anthropol.* 45, 443-452.
- FARKAS, Gy., MARCSIK, A. and OLÁH, S. (1993): A történelmi idők embere Szegváron. - *Anthrop. Közl.* 35, 7-37.
- FRIGO, P. and LANG, E. (1995): Osteoporosis in a woman of the early Bronze Age. - *N. Engl. J. Med.* 333, 1468.

- FRIGO, P., LANG, E., LAUERMANN, E. et al. (1996): Age and sex-dependent differences in bone density in 4000-year-old individuals from an excavation in Unterhautzenthal, Lower Austria. (Abstr.) - *Bone* 18, Suppl. 117.
- GRAY, P. H. K. (1967): The radiography of ancient Egyptian mummies. - *Med. Radiogr. Photogr.* 43, 34-44.
- GRAY, P. H. K. (1973): The radiography of mummies of ancient Egypt. - *J. Hum. Evol.* 2, 51-60.
- GUNNES-HEY, M. (1980): Eskimo presacral vertebral column: variations, anomalies, pathologies. - *Ossa* 7, 99-118.
- GUNNES-HEY, M. (1985): Age-related bone loss in prehistoric Koniag Eskimo population. - *Ossa* 12, 41-47.
- HAHN, K. and CZARNETZKI A., (1980): Premature senescence of the skeleton of a young woman from the Merovingian burial field of Weresheim. - *Anthropol. Contemp.* 3, 137-144.
- HAMADA, G. and RIDA, A. (1972): Orthopedics and orthopedic diseases in ancient and modern Egypt. - *Clin. Orthop. Rel. Res.* 89, 253-268.
- HARRIS, J. E. and WENTE, E. F. (1980): An X-ray atlas of royal mummies. - Univ. Press, Chicago.
- HENN, R. (1993): *Der Mann in Eis. Vol. I.* - Univ. Press, Innsbruck.
- HODLER, J., ULRICH, S. and RÜTTIMANN, B. (1990): Computertomographie in der Paleopathologie. - *Z. Orthop.* 124, 319-321.
- HUSSEIN, M. K. (1949-50): Quelques specimens de pathologie osseuse chez les ancient egyptiens. - *Bull. Inst. Egypte (Cairo)* 32, 11-70.
- HÜBENER, K. H. and PAHL, W. M. (1981): Computertomographische Untersuchungen an ägyptischen Mumien. - *Fortschr. Röntgenstr.* 135, 213-219.
- JÓZSA, L. (1996): A honfoglaló és Árpád-kori magyarság egészsége és betegségei. - *Gondolat, Budapest.*
- JÓZSA, L. and PAP, I. (1996): Az osteoporosis előfordulása a X-XII századi magyarság körében. - *Osteológiai Közl.* 4, 126-129.
- JÓZSA, L., DÓCZI, J. and PAP, I. (1996): Az osteoporosira jellemző combnyaktáji és radiustörések a történeti korokban. - *M. Traumatológia* (accepted for publication).
- KNEISSEL, M., BOYDE, A., HAHN, M., et al. (1994): Age and sex-dependent cancellous bone changes in a 4000 y BP population. - *Bone* 15, 539-545
- KRAMAR, C., LAGIER, R. and BAUD, C. A. (1990): Rheumatic diseases in Neolithic and Medieval populations of Western Switzerland. - *Z. Rheumatol.* 49, 338-345.
- KUO-LIANG, Y., BING, B. Q., YUE, Z. et al. (1982): Skin changes of a 2100-year-old Changsha female corpse. - *Chin. Med. J.* 93, 765-770.
- LAGIER, R., BAUD, C. A., ARNAUD, G. et al. (1982): Lesions characteristic of infection or malignant tumor in Paleo-Eskimos. - *Virchow Arch. Path. Anat. A.* 395, 237-243.
- LEAKEY, M. G., FEIBEL, C. S., MCDUGALL, I. et al. (1995): New four-million-year-old hominid species from Kanopi and Allia Bay, Kenya. - *Nature* 376, 565-571.
- LEES, B., MOLLESON, T., ARNETT, T. R. et al. (1993): Differences in proximal femur bone density over two centuries. - *Lancet* 341, 673-675.
- LEES, B., MOLLESON, T., ARNETT, T. R. et al. (1995): Gender differences in bone loss over two centuries. (Abstr.) - *Bone* 17, 326.
- LESTER, C. W. and SHAPIRO, H. L. (1968): Vertebral arch defects in the lumbar vertebrae of pre-historic American Eskimos. - *Am. J. Phys. Anthropol.* 28, 43-48.
- LEWIN, P. K. (1978): Whole body scan of an Egyptian mummy using X-ray computed tomography. - *Paleopath. Newsletter* 22, 17-18.
- LEWIN, P. K., TROGADIS, J. F. and STEVENS, J. K. (1990): Three-dimensional reconstruction from serial X-ray tomography of an Egyptian mummified head. - *Clin. Anat.* 3, 215-218.
- LEWIN, P. K. (1991): Technological innovation in the investigation of ancient preserved man. In: ORTNER, D. J. and AUFDERHEIDE, A. C. (eds): *Human paleopathology.* - Smithsonian Inst. Press, Washington, 90-91 pp.
- LUZSA, GY., GÁSPÁRDY, G., NEMESKÉRI, J. et al. (1988): Paleoradiológiai tanulmány a székesfehérvári bazilika 15 csontmaradványáról. - *M. Radiológia* 62, 39-50.
- MARX, M. and D'AURIA, S. H. (1988): Three-dimensional CT reconstruction of an ancient Egyptian mummy. - *Am. J. Radiol.* 150, 147-149.
- MOLNÁR, E., MARCSIK, A., FARKAS, L. GY., DUTOUR, O., PANUEL, M. and PÁLFI, Gy. (1996): Szatymaz-Vasútállomás X-XII századi embertani széria paleopathológiai feldolgozása. In: PÁLFI, Gy., FARKAS, L. Gy. and MOLNÁR, E. (eds): *Honfoglaló magyarság - Árpád-kori magyarság.* - JATE Embertani tanszék, Szeged, 235-250 pp.
- MOODIE, R. L. (1931): Roentgenologic studies of Egyptian and Peruvian mummies. - Field Museum, Chicago.
- PALES, L. (1930): *Paleopathologie et pathologie comparative.* - Masson et Cie, Paris.

- PAP, I. and Susa É. (1986): Complex anthropological analysis of cemetery of the comitat center Visegrád. - *Anthrop. Hung.* 19, 51-91.
- PERZIGIAN, A. J. (1973): Osteoporotic bone loss in two prehistoric Indian populations. - *Am. J. Phys. Anthropol.* 39, 87-96.
- PFEIFFER, S. and KING, P. (1983): Cortical bone formation and diet among prehistoric Iroquoians. - *Am. J. Phys. Anthropol.* 60, 23-28.
- PIEPERBRINK, H., FRAHM, J., HAASE, A. et al. (1986): Nuclear magnetic resonance imaging of mummified corpses. - *Am. J. Phys. Anthropol.* 70, 27-35.
- REIMERS, E. G., DE LA ROSA, M. A., MARTIN, L. G. et al. (1988): Bone histology of the prehispanic inhabitants of Grand Canaria. - *J. Paleopath.* 2, 47-59.
- RUFFER, M. A. (1921): Studies on paleopathology of Egypt. - Univ. Press, Chicago.
- SHAW, A. F. B. (1938): Histological study of the mummy Haar-Mose, singer of the eighteenth dynasty (circa 1940 BC). - *J. Path. Bacteriol.* 47, 115-123.
- SIMPER, L. B. (1986): Spondylolysis in Eskimo skeletons. - *Acta Orthop. Scand.* 57, 78-80.
- SMITH, E. G. (1908): The unwrapping of a pharaoh. - *Brit. Med. J.* 1, 732-734.
- SUSMAN, R. L. (1994): Fossil evidence for early hominid tool use. - *Science* 265, 1370-1373.
- THOULD, A. K. and THOULD B. T. (1983): Arthritis in Roman Britain. - *Brit. Med. J.* 287, 1909-1911.
- TRINKAUS, E. and HOWELLS, W. W. (1979): The Neanderthals. - *Sci. Am.* 241, 118-133.
- TRINKAUS, E. and ZIMMERMAN, M. R. (1982): Trauma among the Shanidar Neanderthals. - *Am. J. Phys. Anthropol.* 57, 61-76.
- TRINKAUS, E. (1983): Functional aspects of Neanderthal pedal remains. - *Foot and Ankle* 3, 377-390.
- VAN GREEVEN D. P., ARMELAGOS, G. J. and BARTLEY, M. M. (1969): Roentgenographic and direct measurements of cortical involution in prehistoric Mississippian population. - *Am. J. Phys. Anthropol.* 31, 23-28.
- WALDRON, T. (1990): Note on a mummy from Theban tombs. - *J. Paleopath.* 3, 89-94.
- WEI, O. (1973): Internal organs of a 2100-year-old female corpse. - *Lancet* 1, 1198-1199.
- WELLS, C. (1962): Joint pathology in ancient Anglo-Saxons. - *J. Bone Joint Surg. (Brit.)* 44, 948-949.
- WELLS, C. (1963): Hip disease in ancient man. - *J. Bone Joint Surg. (Brit.)* 45, 790-791.
- WELLS, C. (1964): Bones, bodies and diseases. - Thames and Hudson, London.
- WILLIAMS, H. U. (1927): Gross and microscopic anatomy of two Peruvian mummies. - *Arch. Path.* 4, 26-33.
- WOOD, B. (1992): Origin and evolution of the genus Homo. - *Nature* 355, 783-790.
- WOOD-JONES, P. (1908): The examination of the bodies of 100 men executed in Nubia in Roman times. - *Brit. Med. J.* 1, 736-740.
- WU, Z. B. (1981): Electron microscopic study of a well-preserved 2142-year-old ancient corpse. - *Acta Med. Acad. Wuhan* 1, 7-16.
- ZIMMERMAN, M. R. (1977): Autopsy of an Egyptian mummy (Nakht Rom I.). - *Canad. Med. Ass. J.* 117, 461-476.
- ZIMMERMAN, M. R. (1980): Aleutian and Alaskan mummies. In: COCKBURN, A. (ed.): Mummies, diseases and ancient cultures. - Cambridge Univ. Press, London.
- ZIMMERMAN, M. R., TRINKAUS, E., LE MAY, M. et al. (1981): The paleopathology of an Aleutian mummy. - *Arch. Pathol. Lab. Med.* 105, 638-641.