Bone Mineral Content in Ancient Greenlandic Eskimos

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Bone mineral content (BMC) of the distal forearm was measured by single photon absorptiometry (SPA), and bone mineral density (BMD) of the total arm was measured by dual photon absorptiometry (DPA) in four arms from the archaeological Qilakitsoq Eskimo burial. One arm was within normal Danish range with both SPA and DPA and one arm was subnormal with both methods. One arm from a four-year-old boy which was only measured by SPA was below the lower normal limit, and one arm was inside normal range with SPA, and below with DPA. Although the two methods were not totally in agreement the results indicate the possibility of an increased prevalence of osteopenia in the Qilakitsoq Eskimos.

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Eskimos of Alaska and Canada are subject to an earlier onset and a higher rate of bone loss than US Whites (Mazess & Mather 1974; Mazess & Mather 1975). Children and young adults have values comparable to the white Americans, but after the age of forty both male and female Eskimos have values 10–15% lower (Mazess & Mather 1974; Mazess & Mather 1975). This is supported by some earlier density measurements on bones from an archaeological North American Eskimo population (Mazess & Jones 1972), indicating the absence of a secular explanation of these observations.

We report on measurements of the bone mineral content (BMC) measured by single and dual photon absorptiometry in four arms from ancient Greenlandic Eskimos of the Qilakitsoq archaeological discovery.

Materials and methods

Four arms from the Qilakitsoq find were investigated. Their origins were: a four-year-old boy (I/2), a woman 18–22 years old (II/7), a woman 40–50 years old (I/5), and a woman about 50 years old (II/8). The ages were determined by anthropological methods.

The methods employed in this work for determination of BMC are used routinely in our laboratory for research purposes in studies which aim at the clarification of the calcium metabolism in health and disease. The following two methods were used in the present study.

Single photon absorptiometry (SPA). This method uses a 100 mCi ^{125}I radiation source emitting photons at 27.5 KeV (Christiansen, Rødbro & Jensen 1975). The traditional procedure was modified omitting the water bath in which the forearm of living subjects is usually immersed during measurement. The reason for this was that the air contained in the ancient arms would probably not be replaced by the water and would therefore lead to greater errors in measurement than the absence of the water. Furthermore, the need for a constant thickness of soft tissue/soft tissue equivalent was not so crucial in this study, as the soft tissue remnants were scarce and dried.

Six scans were made on the forearm, starting at the site where the radius and the ulna were 0.8 cm apart and moving proximally in a rectilinear manner, perpendicular to the long axis of the arm (distance between scans = 0.4 cm). BMC was expressed in arbitrary units (dimension: mass per unit length) and was calculated as a mean of six consecutive scans. The method had a long-term reproducibility on healthy subjects of 1%–2% (Christiansen & Rødbro 1977).

BMC by SPA was calculated as the percentage relative to healthy Danes of the same sex and in the same age decade. These normative data have previously been published (Christiansen & Rødbro 1975). The measurement procedure and a computer printout of one scan across the arm are shown in Fig. 1.

Dual photon absorptiometry (DPA). This method is based on the transmission of photons from a radioactive source emitting radiation of two well-defined energy

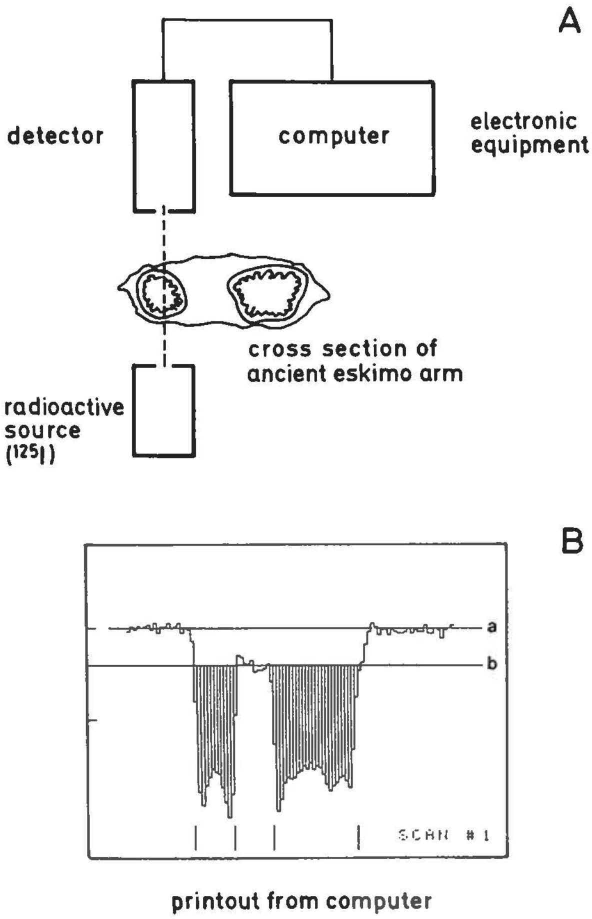

Fig. 1. *A:* BMC measurement procedure (single photon absorptiometry). A schematic cross section of an ancient forearm is shown as well as the radiation source (^{125}I), the detector, and the electronic equipment.
B: A computer printout of the first of the six scans from one of the arms. The profile of the curve expresses the amount of bone mineral. The baseline (*a*) is the beam intensity in air, and the line *b* averages the amount of soft tissues (remains of muscles, connective tissue and skin). The distance from line b to the bone profile curve equals the amount of bone mineral in a particular pixel (one pixel equals the width of a column of the hatching).

levels. We use a 1 Ci ^{153}Gd source with principal photo peaks at 44 and 100 KeV. The DPA scanner at Glostrup Hospital is usually employed as a total body scanner for determination of the body composition in patients and healthy subjects (total body bone mineral, lean body mass, body fat). The apparatus for DPA measurements is shown in Fig. 2. Subjects are scanned in a rectilinear raster pattern with a scan speed of 1 cm per second and longitudinal steps of 2.5 cm. Data are recorded in 0.5 second intervals. The ancient Eskimo arms were measured in the same manner as living subjects.

BMC by DPA is calibrated against dry defatted bones, and is thus expressed in grams dry defatted bone weight, or grams mineral which is 68% of the dry bone value. The precision and accurcy errors of the DPA bone mineral measurements are 1.5% and 2.5% respectively (Gotfredsen *et al.* 1984a, 1984b).

The BMC values of the Eskimo arms measured by DPA were expressed as a bone mineral density (BMD) in grams mineral per cm^2. The measurements were compared to the values of 18 healthy premenopausal and 17

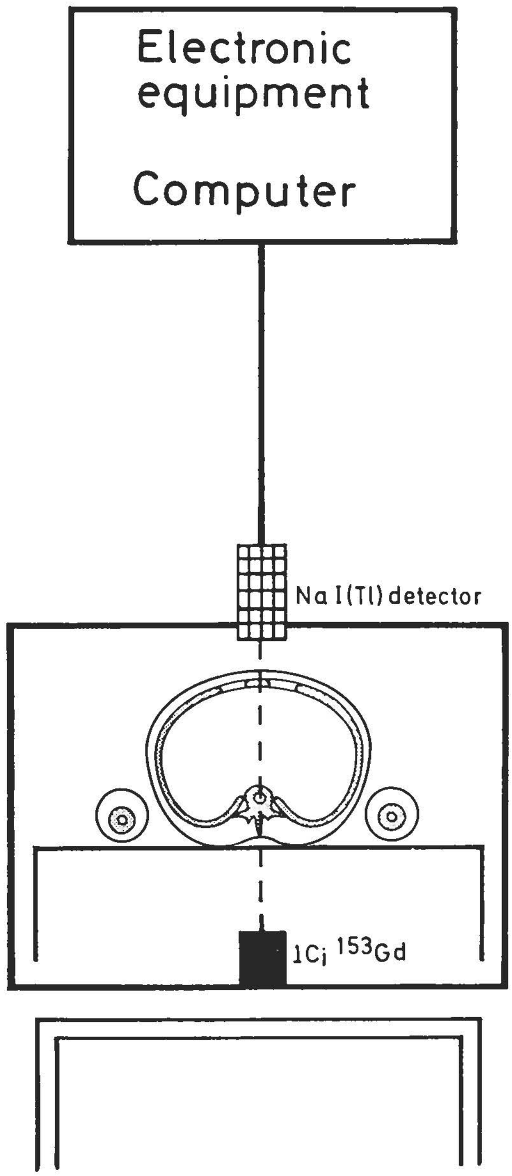

Fig. 2. BMC measurement apparatus (dual photon absorptiometry). A schematic cross section of a subject is seen on the scanner. The radionuclide (^{153}Gd) is placed below the subject and the detector is situated directly opposite, above the subject. During the scanning the subject (or the ancient Eskimo arms) is lying on the couch while source and detector move from side to side, and longitudinally by 2.5 cm steps.

healthy postmenopausal Danish women in which the BMD of the arms had been selected from the total measurement by computer techniques. These healthy women have been described elsewhere (Gotfredsen *et al.* 1986). The BMD by DPA was calculated as the percentage relative to the values of the healthy women.

Results

The result of the bone mineral determination by SPA is given in Fig. 3. The average bone mineral content in the distal forearms in healthy Danes was set at 100%. The normal range was chosen as mean ± 2 standard deviations (hatched area in Fig. 3). If a BMC measurement lies within this area (i.e. 77% – 123%) it is regarded as normal. Two of the Eskimo arms (II/7, 18–22-year-old woman and II/8, 50-year-old woman) had BMC ratings within the Danish normal range (91% and 97%, respectively). Two of the arms fell below the lower limit of normal range (I/2, four-year-old boy and I/5, 40–50-year-old woman) with 71% and 63% respectively.

The arm from the four-year-old boy was not measured by DPA because its dimensions were too small to give a reliable result with this method. BMD measured by DPA for the three arms from the adult women is shown in Fig. 4. The mean BMD of the 35 healthy women is denoted by 100%. The normal range (hatched area) was chosen as mean ± 2 standard deviations (83% – 117%). One of the Eskimo arms (II/7) was close to the normal mean, whereas the other two (II/8 and I/5) were below the lower limit of the normal range.

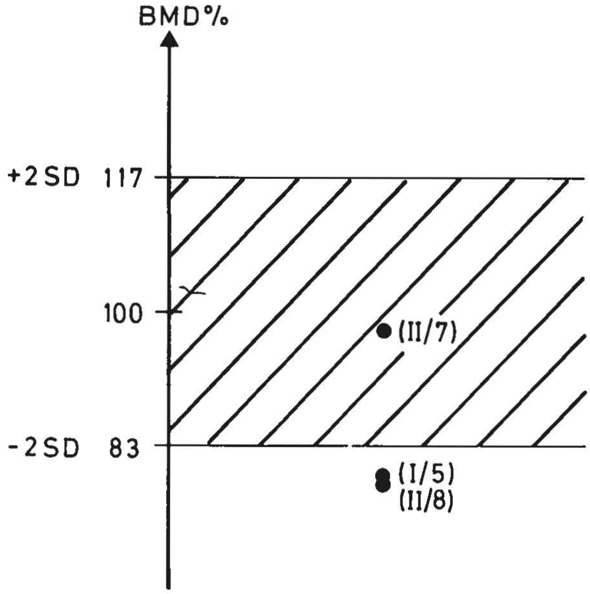

Fig. 4. BMD by dual photon absorptiometry of three ancient Eskimo arms. BMD is given as a percentage of corresponding normal Danish mean. The hatched area is normal mean ± 2 standard deviations.

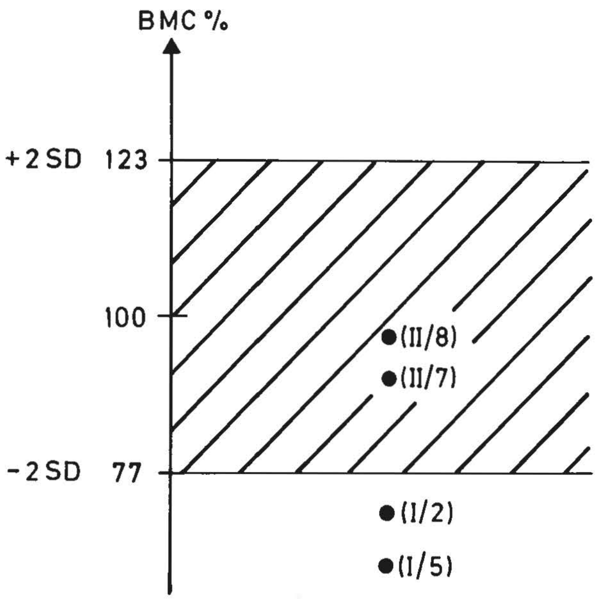

Fig. 3. BMC by single photon absorptiometry of four ancient Eskimo arms. BMC is given as a percentage of corresponding normal Danish mean. The hatched area is normal mean ± 2 standard deviations.

Discussion

The small sample size does not permit us to draw any extensive conclusions. The differences between results with single and dual photon absorptiometry may have several origins. First, the control materials for the two different methods were not the same. Second, the distral forearm BMC by SPA may not be totally indicative of the total arm BMD by DPA. Third, the modification of the ordinary distal forearm SPA measurement to suit the purpose of the present investigation may have introduced some systematic error.

However, one arm (II/7) was consistently inside the normal range with the two methods, and one arm (I/5) was below the normal range with both SPA and DPA. The child arm was below normal range with SPA, and arm No. II/8 was below normal range with DPA. A low bone mineral content (and density) is therefore detectable in ancient Eskimo arms, indicating the presence of osteoporosis.

The reason for early bone loss in Eskimos is not fully explained. The acidic effect on calcium excretion of a diet with high protein (meat) content has been proposed (Mazess & Mather 1974), and serum concentrations of calcium have been found in Greenland Eskimos that were significantly lower than those of subjects living in Denmark (Jeppesen & Harvald 1983).

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