BONE MASS AND AGE - RELATED BONE LOSS IN NORMAL TURKISH POPULATION

Metin VURAL , M.D., Serhan ATİLLA, M.D., Cem YÜCEL, M.D., Sergin AKPEK, M.D., Mehmet Araç M.D., Erhan T. ILGIT M.D., Sedat IŞIK, M.D.

Gazi University, Faculty of Medicine, Department of Radiology, Ankara, Turkey
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SUMMARY : *To define the normative values of bone mineral content (BMC) and age related bone loss in our population, we measured vertebral trabecular BMC in 115 healthy Turkish males and 370 healthy Turkish females by single energy quantitative computed tomography. Obtained normative data were analyzed using regression analysis. Our results confirm the widely reported age - related bone loss. We find that our normative data is similar to those reported from American and British population in young males and females but annual rates of bone loss are higher. We think that our results emphasize the importance of locally obtained data for every country.*

Key Words : *Bone Mineral Content, Osteoporosis, Computed Tomography.*

INTRODUCTION

Osteoporosis, the most common metabolic bone disorder, is characterized by a reduction in bone mass that compromises the biomechanical integrity of the skeleton resulting in considerable morbidity, mortality and public health expenditure (9). In recent years various techniques of quantitative skeletal assessment have been developed for detection of accelerated bone loss, monitorization of progression and response to therapy.

Simple bone radiography is not a reliable method to diagnose early bone loss because losses of bone mass up to 40 percent may occur without a noticeable change (10). Single and dual energy photon absorptiometry (SPA and DPA), quantitative computed tomography (QCT) and dual photon x-ray absorptiometry (DEXA) techniques have been studied most extensively in bone mass measurements and are now widely used. Using such measurements osteoporosis can be defined as a condition in which the bone mineral content (BMC) at the site of measurement is more than two standard deviations below the normal age - and sex -matched mean value (3). There are few published data on normal values for bone mineral content obtained by QCT in Turkey and no large series containing Turkish subjects from both sexes over a large age range has been published. We measured BMC in spinal trabecular bone in 485 normal Turkish subjects, using single energy QCT technique and the normative data for males and females were analyzed using regression analysis.

MATERIALS AND METHODS

We measured bone mass in spinal trabecular bone in 370 healthy Turkish females aged 16-75 and 115 healthy Turkish males aged 16-77. The mean age was 47.4 in females and 42.3 in males.

All subjects were either healthy volunteers re-

ferred for CT examination of other parts of their bodies such as cranium, extremities or healthy persons who were admitted for osteoporosis screening. On choosing the healthy subject group, cases with nontraumatic fractures, recent immobilization, and rheumatoid, endocrine, renal, hepatic or gastrointestinal disorders known to produce abnormalities in bone or calcium metabolism were excluded from participation. Use of medication known to cause osteopenia was another criteria for exclusion. All subjects had normal hemoglobin, calcium, phosphorus, alkaline phosphatase, creatinine, alanine and aspartate aminotransferase levels. All patients were informed about the research and accepted to take part in.

All patients were scanned by using General Electric model 9800 CT scanner (GE Milwaukee, Wisconsin) in supine position with their backs in contact with a curvilinear plexiglass phantom containing standard solutions of K_2HPO_4. Localization was achieved by a lateral scout view, with the midplane of each of the four vertebrae identified by cursor-determined coordinates. At the completion of axial scanning a region of interest was generated over each axial section using the commercially supplied software. The region of interest was chosen as large as possible, excluding the cortical bone and any regions of non uniformity (the posterior venous outflow sites or areas of endosteal sclerosis). Representative volumes (approximately 4 cm^3) of purely trabecular bone at the midplane of first to fourth lumbar vertebral bodies were quantified and averaged, and the results were expressed in mineral equivalents of K_2HPO_4 in mg per cm^3.

Technical factors were 80 kVp, 70 mA, 1 cm slice thickness and 2 second scan time (7). The total examination time was about 10-15 minutes and the radiation exposure was approximately 250 mREM (5), the resultant gonadal dose being less than 10 mREM (10).

After BMC was measured in spinal trabecular bone, normative data were analyzed using cubic and linear regression analysis for females and males, respectively. The significance of the correlation coefficients were tested by a paired t-test.

RESULTS

The values obtained from spinal trabecular BMC in L1-L4 for normal Turkish males and females are shown in Figures 1 and 2. Highly significant negative correlations between BMC and age were found in both sexes ($p<0.001$). The mean BMC value is 136.9 ± 33.0 in males and 124.7 ± 38.3 in females. The normal mean value for young males and females is approximately 170 mg/cm^3.

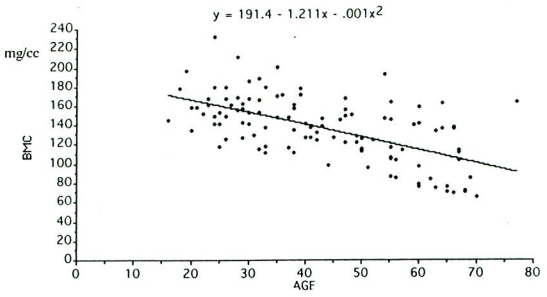

Fig - 1 : Normal BMC values for males using a linear regression with 95 percent confidence intervals.

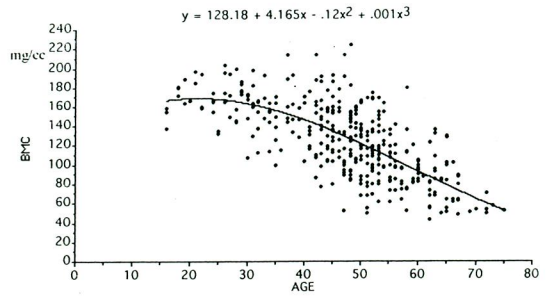

Fig - 2 : Normal BMC values for females using a polynominal cubic regression with 95 percent confidence. An accelerated bone loss after menopause is observed.

Males, by linear regression, were found to lose an average 1.4 percent of bone per year so that by age 70, the mineral content is reduced by 42 % to approximately 100 mg/cm^3. Females, by cubic regression, lose an average 2.04 % per year and by

age 70, the mineral content is reduced by 60 % to approximately 70 mg/cm^3.

Annual rates of bone loss in females are accelerated at menopause. Women, aged between 45 to 75, loose an average 2.8 % of their BMC per year.

DISCUSSION

Osteoporosis is a condition of decreased bone tissue that increase the likelihood of a fracture. Because there are no symptoms until fractures occur, and no blood or urine test establishes specifically the diagnosis of primary osteoporosis; relatively few patients are diagnosed in time for effective therapy (4, 9).

The selection of anatomic sites and methods for quantifying skeletal mass is important. About 80 percent of the skeleton is composed of cortical or compact bone, and 20 percent is trabecular or cancellous bone (10). Trabecular bone has a high turnover rate about eight times that of compact bone, partly because of its high surface-to-volume ratio (5). This high turnover rate makes trabecular bone a sensitive measurement site that is highly responsive to metabolic stimuli and probably accounts for the clinical observation that osteoporotic fractures occur first in the vertebral bodies or distal radius, areas of predominantly trabecular bone (5). Osteopenia with artificial or natural menopause is about twice as great in the spine as the appendicular skeleton (8). Additionally, trabecular bone is the most affected skeletal region by medications utilized in the treatment of osteoporosis (2, 8). We analyzed bone mineral density of the lumbar spine by single energy QCT as spine is the region containing the highest percentage of cancellous bone (two-thirds cancellous and one-third compact bone) (5).

There are several modalities for bone mineral measurements. Single energy QCT has several advantages as follows: It gives the possibility to measure the area of almost exclusively trabecular bone within the vertebral body, it can predict vertebral fracture risk and can be utilized to monitor the response of bone mass to therapy, it has acceptable precision and radiation exposure and CT scanners are available in most centers (1, 2, 5).

One problem is the fat constituent, which tends to give underestimated values for the bone mineral content but Genant et al. have concluded that the fat-induced random error is only about 1/4 that of the biologic variations or pathologic range and is not large enough to compromise the use of QCT techniques (6).

The present study establish values of BMC for normal Turkish females and males over a large age range by using QCT. Our results confirm the widely reported age related loss of trabecular bone in both sexes. Values for spinal trabecular BMC for young males and females were similar to those of normal American and British populations but the rates of bone loss from the vertebrae calculated from our data were higher than the values reported by Genant et al and Compston et al. (3, 5). In our study, the annual rates of bone loss are calculated to be 1.4 % in males and 2.04 % in females. In British population, the annual rates of bone loss of 0.8 % in males and 1.1 % in females are similar to those reported for American normal ranges. This difference probably result from a combination of racial and geographical factors and emphasize the importance of using locally obtained normal values for comparison with data obtained from osteoporotic patients. A coefficient of variation between CT scanners was found to be 3-4 percent (5). This indicates that our normative data obtained on GE 9800 scanner may be extrapolated to those obtained on different CT scanners, in our population.

Correspondence to : Dr.Sergin AKPEK
Gazi Üniversitesi Tıp Fakültesi
Radyoloji Anabilim Dalı
Beşevler
06500 ANKARA - TÜRKİYE
Phone : 312 - 212 19 40

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