SCIENTIFIC ARTICLE

Correlation Between Distal Radial Cortical Thickness and Bone Mineral Density

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Purpose To determine interobserver reliability in measuring the cortical thickness of distal radiuses on posteroanterior radiographs obtained at the time of injury and to determine whether there is a correlation between distal radius cortical thickness and hip and lumbar spine scores on dual-energy x-ray absorptiometry (DXA).

Methods Four orthopedic surgeons at 2 academic institutions who were blinded to the study protocol reviewed standard posteroanterior wrist radiographs of 80 women over age 50 years with distal radius fractures with DXA data obtained within the past 2 years. Radial bicortical widths were measured at 50 and 70 mm proximal to the distal ulnar articular surface, and mean bicortical thickness was calculated from radiographs of the injured wrist. Average bicortical width was compared with each patient's femoral and lumbar spine bone density measures. Data were analyzed using Pearson correlation coefficients and simple linear regression. Inter-rater reliability was evaluated using intra-class correlation coefficients.

Results The inter-rater reliability for average bicortical thickness had a high intra-class correlation coefficient value of 0.91. Average bicortical thickness showed a statistically significant positive relationship with femoral bone density. Average bicortical thickness was statistically correlated with femoral bone density values, with a 1-mm increase in average bicortical thickness associated with a 0.05 g/cm^2-increase in femoral density. Average bicortical thickness was not associated with lumbar bone density.

Conclusions Bicortical thickness of the distal radius was positively correlated with femoral bone density but not with lumbar spine density. This may reflect similarity in quality and loading properties of the femur and radius as appendicular bones, compared with the axial spine. Identification of thinned distal radial cortices in association with distal radius fracture is a simple qualitative observation that should prompt further evaluation with DXA and medical management of bone insufficiency. *(J Hand Surg Am. 2015;40(3):493−499. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Diagnostic II.

Key words Distal radius fracture, bone mineral density, osteoporosis, cortical thickness, fragility fracture.

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Received for publication August 28, 2014; accepted in revised form December 8, 2014.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/15/4003-0012$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2014.12.015

Distal radius fractures are a common injury in elderly women and often occur in the setting of underlying osteopenia or osteoporosis. Women presenting with distal radius fractures are at increased risk of hip and lumbar compression fractures.[1–3] Reed et al[1] reported that 50% of women have osteoporosis at the time of distal radius fracture and many never receive treatment for osteoporosis.

The diagnosis of osteoporosis is based on dual-energy X-ray absorptiometry (DXA), currently considered the reference standard for determining bone mineral density.[4] However, referral for DXA after fragility fracture does not occur consistently.[5] Barriers to diagnosis and treatment of osteoporosis after a fragility fracture include lack of access to DXA, cost of medications, lack of compliance with medication, and hesitation of treating physicians to take on management and referral for DXA. As an alternative, Barnett and Nordin[6] originally investigated correlations between cortical bone thickness and bone mineral density in 1960 and developed the metacarpal index, a measure of bicortical width scaled to the cortical diameter of the middle finger metacarpal, which was associated with age and bone mineral density. More recently, Mather et al[7] demonstrated a correlation between proximal humeral cortical thickness and bone mineral density.

Standard plain radiographs are generally obtained for every patient with a distal radius fracture at various intervals. Based on previous use in the hand and shoulder, potential use of these radiographs to estimate bone density presents a simple, inexpensive, and efficient adjunct for initial identification and screening of osteoporosis. The purposes of this study were to determine interobserver reliability in measuring the cortical thickness of distal radii on posteroanterior (PA) radiographs obtained at the time of injury and to determine whether there is a correlation between distal radius cortical thickness and hip and lumbar spine scores on DXA. We hypothesized that there would be a statistically significant positive correlation between cortical thickness and DXA scores. We also hypothesized that cortical thickness on PA wrist radiographs could be used as an inexpensive and simple initial tool for evaluating osteoporosis.

MATERIALS AND METHODS

After we obtained institutional review board approval, we analyzed a subset of data collected as part of a cross-sectional study of postmenopausal women with distal radius fractures conducted at 2 academic institutions. Between 2011 and 2013, DXA scans were obtained for 80 consecutive women over age 50 years who had sustained distal radius fractures. This group had a mean age of 66 years (range, 50−94 y); 81% were Caucasian, 9% were black, 8% were Hispanic, and 2% were classified as other background. Average body mass index of the cohort was 26 (range, 18−44).

Patients were referred for DXA at 3 months after fracture. If the patient had previously had DXA evaluation within 2 years of fracture and these data were available, we did not repeat the study. Dual-energy x-ray absorptiometry measures included areal bone mass density in grams per square centimeter (areal refers to bone mineral density calculated using area, not volume) and reference T scores for the hip and lumbar spine. Cortical thickness measures were made on digital PA injury radiographs or if not available, the first series of radiographs without obscuring external or internal immobilization. Eleven patients were excluded because the radiograph did not extend 70 mm proximal to the distal radial ulnar joint (DRUJ) to make cortical measurements. Eight patients were excluded because of incomplete DXA data. A total of 61 of 80 eligible patients (76%) were included for analysis.

Measures of cortical thickness

The method of measurement and analysis of cortical bone thickness used in this study was based on work by Mather et al,[7] who examined the relationship between bone mass density and cortical thickness of the proximal humerus. We downloaded PA radiographs from both institutions' picture archiving and communications system. Before analysis, all patient identifiers were removed. Images were then uploaded to a file-sharing service (http://www.dropbox.com) to allow access to radiographs. We used the ImageJ processing program (ImageJ, National Institutes of Health, Bethesda, MD) to make all radiographic measurements. Varying image magnification was accounted for by standardizing longitudinal capitate length on all radiographs. Longitudinal capitate length was set to 21.65 mm as determined by Schuind et al.[8] The following measurements of cortical thickness of the distal radial diaphysis were collected: average bicortical thickness (BCT), defined as the average of the width of the cortex taken at 2 separate locations on the distal radius; gauge cortical bone thickness 1 (GT_1), defined as the BCT divided by the diameter of the radius measured 50 mm proximal to the DRUJ; and gauge cortical bone thickness 2 (GT_2), defined as the BCT divided by the average of the