EVALUATION OF BODY COMPOSITION AND TOTAL BODY BONE MASS WITH THE HOLOGIC QDR-4500. T. Fuerst, H.K. Genant, University of California, San Francisco, CA.

PURPOSE: The new Hologic QDR-4500 densitometer provides improved image quality and significantly reduced scans times over previous models. This is especially true for the whole body scan. In this study we compared body composition and bone mass measurements made with the QDR-4500 to those of the QDR-2000. METHODS: Fifty-eight healthy women aged 23-70 yrs (48±14 yrs) and weighing 48-116 kg (63±12 kg) underwent whole body scans on a QDR-2000 (pencil beam) and on a QDR-4500 (fan beam). All scans were analyzed using the Enhanced Whole Body algorithm. Bone mineral density (BMD), lean tissue mass (LTM), fat tissue mass (FTM) and body fat percentage (%FAT) were determined from the DXA scans. Precision of the measurement was assessed by evaluation of duplicate scans with intermediate repositioning in a subset of 35 women. Agreement between the two machines was determined by linear regression. RESULTS: Precision of the whole body measurements was very good and similar to that reported previously. Precision of BMD was 0.009 g/cm2 (0.8%) while soft tissue precision was 430 g (1.0%), 440 g (2.1%) and 0.7% for LTM, FTM and %FAT, respectively. Data from the two machines were very highly correlated with correlation coefficients greater than 0.98. Root mean square error (RMSE) of the regression fit is shown in the table. Regression slopes were not significantly different from one for BMD or LTM, however there was a systematic underestimation of FTM (~13%) and %FAT (~5%) by the QDR-4500 relative to the QDR-2000.

	Precision (%)	Corr. Coeff.	RMSE (%)	Slope
BMD (g/cm2)	0.009 (0.8)	0.98	0.02 (1.9)	0.97
LTM (g)	430 (1.0)	0.99	720 (1.8)	1.00
FTM (g)	440 (2.1)	0.99	860 (4.0)	0.87
%FAT (%)	0.7 (2.3)	0.99	1.2 (3.6)	0.95

CONCLUSION: With the exception of fat tissue mass, the QDR-4500 gives results equivalent to the QDR-2000. This difference in FTM is being investigated by the manufacturer and may reflect an incorrect calibration or a problem specific to our scanner. The greatly reduced scan time (3 min vs. 12 min) should increase the utility of the whole body measurement and be more acceptable to patients.

PMo474

SEGMENTATION OF CORTICAL AND TRABECULAR BONE IN PQCT

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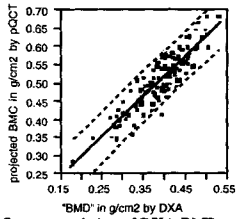
To evaluate different segmentation procedures for the separation of trabecular and cortical bone by peripheral quantitative computed tomography(pQCT) at the distal radius and to compare with measurements of bone mass by dual x-ray absorptiometry(DXA) at the same site.

In 40 postmenopausal healthy (age 64±9) and 34 postmenopausal osteoporotic(atraumatic vertebral fractures, age:70±6) females the distal radii were examined with pQCT(Stratec XCT960) and DXA(Hologic QDR 2000). Trabecular and cortical bone of the distal radius were separated by peeling off the cortical bone (default mode: 55%peeling) or by thresholding procedures with different settings of the segmentation parameters. The results of the segmentation procedures and of the two different modalities were compared using linear regression analysis.

The area identified as trabecular bone related markedly to the segmentation mode. Thresholding resulted in up to 60% larger areas of trabecular bone as compared to peeling (mean: 19%±12%). The cortical bone mineral density (Cortical BMD) did significantly depend on the segmentation mode. Differences of up to 20% were observed. Trabecular BMD changed up to 30% depending on the segmentation mode used. Correlations of pQCT with DXA-BMD were slightly higher using thresholding modes as compared to peeling mode.



Strong correlation of DXA-BMD and pQCT-BMC divided by radial projected area(R=.89,CV=7%, p<0.001).

The default segmentation mode failed to exactly represent the trabecular area in cases of thick cortices or square radius contours. An additional peeling of 5-10% could correct for the error. Segmentation by thresholding did strongly depend on the threshold level and underrepresented the amount of trabecular bone in cases of dense trabecular bone attached to the endosteal cortex. Therefore, assessment of osteoporosis with pQCT should carefully consider the scanning mode. An individual verification of the segmentation procedure is highly recommended.

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FOREARM PQCT PREDICTS IN-VITRO FRACTURE LOAD AT THE FEMORAL NECK

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To evaluate the capability for fracture load prediction by combined measurements of densitometric and geometric properties at the femoral neck and the distal forearm by peripheral computed tomography (pQCT).

The right femur and the right radius of 20 cadavers (13 female, age 85±8; 7 male, age 77±6) were examined by pQCT (Stratec XCT960) and the mineral densities and geometric properties of cortical bone and trabecular bone were determined. The femurs were subjected to biomechanical testing (Zwick1445) until failure in a one legged stance configuration. PQCT results at both sites were compared by linear regression analysis with each other and with the loads to failure of the femoral neck. Differences between male and female bones were statistically tested by a nonparametric Wilcoxon test.

Geometrical properties of the femoral neck differed between male and female bones ($p<0.05$) while trabecular and cortical bone mineral densities were not. At the distal radius all properties, besides the cortical bone mineral density, differed significantly between men and women($p<0.05$). Eighteen fractures of the femoral neck were observed with significantly($p<.01$) larger fracture loads for men(5.9±1.8kN) as compared to women(3.1 ±1.2kN). The fracture loads of the femurs were significantly correlated with the geometric properties and with the mineral densities at the femoral neck and at the distal radius(R values see Correl. table, #: significant after adjustment for bone size and age $p<0.01$).

Correl. with fracture load	pQCT radius	pQCT femur
Trab. BMD	0.60	0.60
Cortical BMD	p>0.05	0.58 #
Total BMC	0.81 #	0.85 #
Cortical area	0.84 #	0.66
Mom. of Inertia	0.87 #	0.84 #

Fracture load of the femoral neck was strongly related to the results of pQCT measurement at the distal forearm. Both, the geometry of the cortical rim and the density of the trabecular bone of the femur as well as the radius are significantly related to the strength of the femurs. Osteoporosis screening and fracture risk prediction, therefore, can be improved by additional consideration of geometrical properties of the cortex.

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RELATIONSHIP BETWEEN OSTEOPOROTIC STATUS AND TRABECULAR BONE STRUCTURE ASSESSED USING HIGH RESOLUTION MAGNETIC RESONANCE IMAGING IN THE DISTAL RADIUS

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High resolution magnetic resonance (MR) techniques combined with standard techniques of stereology and texture analysis are used to determine the relationship between trabecular bone structure parameters, age, and measures of bone mineral density (BMD) and bone mineral content (BMC) in the distal radius. MR images of the distal radius were obtained in 15 premenopausal (Group I), 10 post-menopausal normal (Group II) and 10 postmenopausal with atraumatic vertebral fractures (Group III), using a 1.5 Tesla Signa (General Electric) imaging system. Sixty axial slices starting at the distal joint line were obtained with an in-plane resolution of 156 μm and a slice thickness of 700 μm. Image thresholding and boundary detection techniques were used to identify the trabecular bone, marrow, and the interface between both phases. The mean trabecular intercept length, trabecular width, fractional area of trabecular bone, trabecular spacing, trabecular number as well as texture-related parameters such as the fractal dimension (D) were derived from the images. Peripheral QCT (one slice of 2.5 mm thickness) measurements were made approx. 10 mm from the joint line in the distal radius to obtain a measure of trabecular BMD. In addition, BMC in the cortical rim was measured in each of the subjects using pQCT. In a subset of patients Quantitative Computed Tomography (QCT) was used to determine the spinal bone mineral density. The results are shown in the Table below. Differences between the groups was assessed using t-test and for the sample size the level of significance was set to $p<0.1$.

	age (yrs)	pQCT(mg/ml)	BV/TV	Tb.Th (mm)	Tb..Sp (mm)	Tb. N (mm^{-1})	D
I	31±8	202.0±23.5	.33±.09	0.7±0.2	1.54±0.7	0.45±0.1	1.48±0.08
II	58.5±8	192.9±40.2	.32±.08	0.67±0.1	1.73±0.7	0.44±0.1	1.45±0.08
III	70.4±8	147.3±60.9	.26±.08	0.67±0.1	2.68±1.4	0.33±0.1	1.34±0.17

Significant differences existed in age, QCT, pQCT, BV/TV, Tb.Sp, Tb.N, D between fracture and non-fracture groups and no significant difference was seen in TbTh. There was a significant difference in age, QCT, but considerable overlap and no significant difference in the bone mineral density and structure parameters in the radius between groups I and II. The relationship between pQCT, age and trabecular structure showed moderate - good correlations as demonstrated previously. The severity of fractures was graded as mild, moderate, severe and trabecular spacing was the greatest in the severe and lowest in the mild cases. In summary, MR appears to be extremely promising tool for assessing the impact of trabecular bone structure in osteoporosis and larger studies are clearly warranted.

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