Quantification using Textural Analysis on MR Bone Data

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Clinical Background: The aim of this study is to demonstrate the potential of basic textural analysis (TA) tool for possible quantification of trabecular bone from magnetic resonance imaging (MRI) data. A preliminary quantification was performed on axial images from MRI at distal radius and tibia which were compared with peripheral quantitative computed tomography (pQCT) and MRI quantification results from previous work [1, 2 & 3]. The study and volunteers (n = 169) were based from high bone mass (HBM) study funded by Wellcome trust. The HBM study was based on identifying individuals who were affected by a specific gene mutation by a multi-modality imaging technique. pQCT and MR data were acquired at similar locations for comparison and effective quantification in 52 female individuals from the total HBM study population. pQCT data provided bone mineral density (BMD) as a factor of bone density and strength. MRI data provided bone volume fraction (BVF) as a factor of trabecular bone network in relation to bone strength. pQCT data was acquired using Stratec XCT 2000 scanner and MRI data was acquired using a 3.0 Tesla GE MR750 (Milwaukee, USA) system. The MR images at distal radius and tibia were processed using in-house software through MATLAB which performed BVF and textural quantification from the segmented trabecular bone of radius and tibia. Five basic textural properties of Entropy, Contrast, Correlation, Energy and Homogeneity were performed on the segmented bone using default MATLAB commands. The MR images were converted to a gray-level co-occurrence matrix (GLCM) data before textural quantification.

Results: Effective segmentation of trabecular bone was possible by the software and was able to measure structural properties from the segmented bone alone *Figure 1*. The results illustrate good correlation for radius and tibia between BMD (pQCT) and BVF (MRI) (R^2 = 0.575-0.664, p = .000). *Table 1* Illustrates data for radius with moderate correlation for textural properties of Energy (R^2 = 0.2116-0.3103, p = .003-.000) and Homogeneity (R^2 = 0.2510-0.2787, p = .001-.000) in relation to BMD and BVF. *Table 2* Illustrates data for tibia with moderate correlation for textural properties of Correlation (R^2 = 0.3733-0.4928, p = .000) and Homogeneity (R^2 = 0.1953-0.2227, p = .001-.000) in relation to BMD and BVF. Poor correlation is observed for textural data of Entropy and Contrast in relation to BMD and BVF.

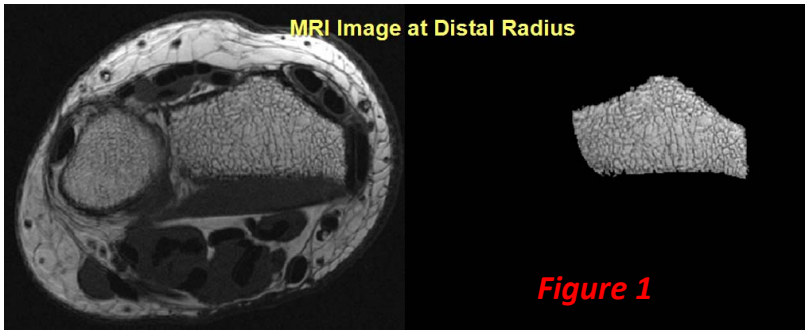

Table 1

Radius	BMD mg/ccm	BVF %	Entropy	Contrast	Correlation	Energy	Homogeneity
BMD R^2	-	**0.575**	0.0137	0.1989	0.1082	**0.3103**	**0.2787**
p	-	**.000**	.461	.003	.034	**.000**	**.000**
BVF R^2	**0.575**	-	0.0003	0.1521	0.1037	**0.2116**	**0.2510**
p	**.000**	-	.909	.014	.045	**.003**	**.001**

Table 2

Tibia	BMD mg/ccm	BVF %	Entropy	Contrast	Correlation	Energy	Homogeneity
BMD R^2	-	**0.664**	0.105	0.2016	**0.3733**	0.1011	**0.2227**
p	-	**.000**	.020	.001	**.000**	.023	**.000**
BVF R^2	**0.664**	-	0.0292	0.1797	**0.4928**	0.0605	**0.1953**
p	**.000**	-	.226	.002	**.000**	.079	**.001**

Discussion: The data illustrates the potential of the software for bone in relation to segmentation and quantification. The results illustrate moderate correlation of textural data with MRI and pQCT. The study shows the value of certain textural properties which can be used for bone quantification in conjunction with MRI or pQCT. Preliminary results describe a great potential for textural analysis for in-vivo bone quantification.

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References: 1. G.P. Liney, *et al*, *JMRI* 26:787-793 (2007)
2. P. Gibbs, *et al*, *MRM* 50: 92-98 (2003)
3. V.R. Lazar, *et al*, *Proc. 18th ISMRM*, [784 & 785] (2010)