Clinical evaluation of the compact MRI system for trabecular bone microstructure measurements of the finger

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Introduction

Trabecular bone (TB) microstructure measurements are essential for estimation of bone strength and drug therapy assessments for osteoporosis [1,2]. We have developed a compact MRI system for the finger using a 1.0 T permanent magnet for this purpose [3]. In this work we measured TB microstructure of the finger of 51 normal subjects and 230 patients using this system to evaluate its clinical efficacy.

Materials and Methods

Fifty one normal female subjects (age:19-62, mean:34.1, SD:12.4) and 230 female patients participated in this project. Because the MRI measurement was performed as one of routine bone density measurements in the university hospital, the patients were not always classified into osteoporosis. After the informed consent was obtained, the distal middle phalanx of the middle finger of the nondominant hand was imaged using a 3D driven equilibrium spin-echo sequence (TR/TE = 50 ms/6 ms, acquisition matrix = 112×112×128, reconstruction matrix = 256^3, spatial resolution 180 μm×180 μm ×160 μm, image acquisition time = 11 min.). A compact MRI with a 1.0 T permanent magnet developed for TB microstructure measurements of the finger was used [3]. 30 contiguous axial slices (2.4 mm thick slab region) were analyzed using a bone structure analysis software package (TRI3D/BON, Ratoc System Engineering, Tokyo, Japan) after the threshold value between TB and bone marrow was calculated using a histogram deconvolution technique [4].

Results and Discussion

Forty six normal subjects and 119 patients were successfully measured without motion effect. To compare the bone microstructure parameters with patients, 27 normal subjects of which age ranged from 20 to 44 were selected. Correlation coefficients between bone microstructure parameters calculated for the patients are shown in Table 1. These results clearly demonstrate that most bone microstructure parameters have relatively high correlations between them as one example shown in Fig.1.

Figures 2 and 3 show the number of the patients and the normal young subjects (n=27) plotted against BV/TV and SMI (structure model index). These histograms and student t-tests for the bone microstructure parameters have suggested that BV/TV, Tb.Th, and Tb.Sp are not good parameters, but SMI or TBPf is the best parameter to characterize the pathological status of the TB. Figures 4 and 5 show two typical cross-sectional images with small and large SMI, corresponding to a normal subject (22 yrs) and a patient (40 yrs, Werner's syndrome).

In conclusion, although further development is needed to improve the yield of the MR measurements, our compact MRI system for the finger can be used to characterize the pathological status of the TB.

	BV/TV	Tb.Th	Tb.N	Tb.Sp	TBPf	SMI
BV/TV	-	0.6987	0.4473	- 0.7465	- 0.6192	- 0.5584
Tb.Th		-	0.2332	- 0.1884	- 0.7900	- 0.6907
Tb.N			-	- 0.5110	- 0.3696	- 0.4040
Tb.Sp				-	0.2291	0.2795
TBPf					-	0.9670
SMI						-

Table 1. Correlation coefficients between bone structure parameter of the finger

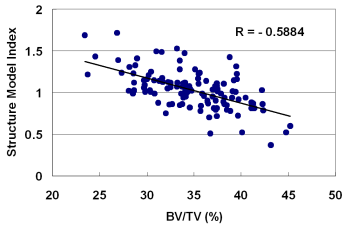

Fig.1 Correlation between BV/TV and SMI

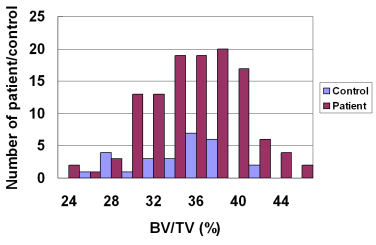

Fig.2 Histogram plotted along BV/TV

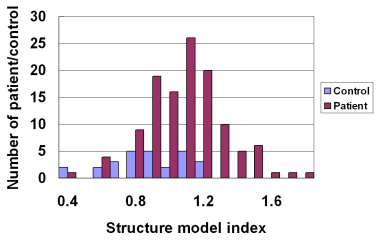

Fig.3 Histogram plotted along SMI

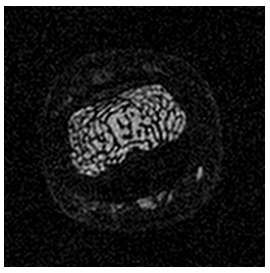

Fig.4 **BV/TV=36.8 SMI=0.369**

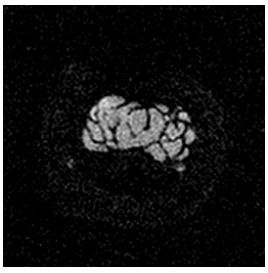

Fig.5 **BV/TV=23.4 SMI=1.686**

References

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