Trabecular bone volume fraction measurements for a large number of subjects

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Abstract

MRI-TBVF (trabecular bone volume fraction) and QUS-SOS (speed of sound) measurements were performed for the right calcanei of 422 healthy female subjects. The TBVF was measured using a compact MRI developed in our laboratory. The results demonstrated a definite correlation between TBVF and SOS and nearly constant T_2 value of bone marrow protons in the calcaneus over the subjects. The nearly constant T_2 suggested 50% scan time reduction for the TBVF measurements.

Introduction

The compact MRI is a new instrument for bone density measurements [1]. In the previous study, however, the number of subjects was limited for comparative study with QUS (quantitative ultrasound). In the present study, the number of subjects was extended to several hundreds to support the usefulness of the instrument and to obtain several quantities used for improvement of the instrument.

Material and methods

422 healthy female volunteers (age: 16-79, mean: 40.4) participated in this study. After the informed consent was obtained, MRI-TBVF (trabecular bone volume fraction) and QUS-SOS (speed of sound) measurements were performed for the right calcaneus. A compact dedicated MRI with a 0.21 T and 16 cm gap permanent magnet was used for the MRI measurements. The method for TBVF measurement was the low-resolution MRI method [1,2]: two 2D single spin-echo sequences (TR/TE=1200ms/12ms and 1200ms/96ms) were used to correct the T_2 decay to obtain the proton density of the bone marrow. The total measurement time for two 128 x 128 pixel images was about 2.5 minutes, because the doubly zero-filled interpolation technique was applied for the 64-step phase encoding direction. The single spin-echo sequences were used because it was robust for the RF magnetic field inhomogeneity, which was inevitable for the compact MRI. The TBVF was calculated from the proton density in the 1.6 ml orthogonal region (Fig.1) in the calcaneus. SOS measurements were performed using a commercially available QUS instrument (DM-US100: Panasonic).

Results and discussion

Figure 2 shows correlation between TBVF and SOS. The correlation coefficient R^2 was 0.199, which was not large, partly because the measurement location for QUS was not specified. Figure 3 shows the T_2 histogram of bone marrow protons measured in the ROI shown in Fig.1. As seen from the figure, the T_2 distributes in a narrow range (mean: ~83 ms). Furthermore, no correlation was observed between T_2 and TBVF, T_2 and BMI (body mass index), and T_2 and age. These results suggest that the T_2 measurements may be skipped: even if we used the average T_2 value (82.6 ms) instead of the measured T_2 value for TBVF calculation, the change of TBVF is less than 1% for 95% subjects. Because the CV (coefficient of variance) for long-term measurements in our system is about 1%, T_2 measurements can be skipped for most subjects. This means that we can shorten the total measurement time down to 1.25 minutes. In conclusion, the MRI-TBVF and QUS-SOS measurements for a large number of subjects demonstrated a definite correlation and possibility of 50 % reduction for the TBVF measurement time.

References

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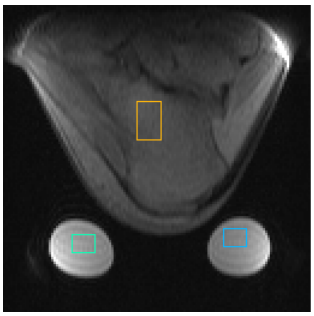

Fig.1 Sagittal image of the calcaneus used for TBVF calculation

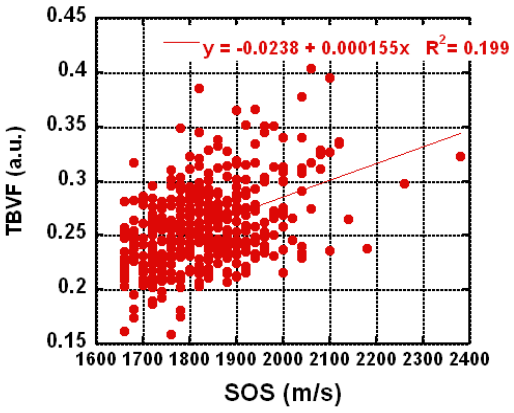

Fig.2 Relation between MRI and QUS for 422 subjects.

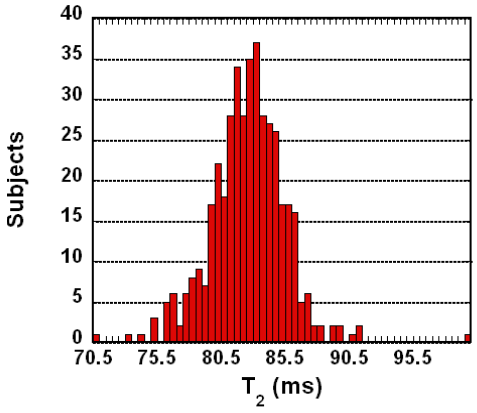

Fig.3 T_2 of bone marrow protons for 422 subjects.