**Background**

Osteoporosis is becoming more prevalent—the number of hip fractures is expected to double in the next 20 years due to an aging population [1], and currently costs the NHS around £4 billion per annum [2]. There is a need to accurately diagnose and potentially intervene in patients at risk prior to a fracture occurring.

Trabecular bone structure is known to be abnormal in osteoporosis, leading to increased risk of fragility fracture [3], but these structural changes are not currently used in diagnosis. DXA, the current gold standard for osteoporosis diagnosis and prediction of fracture risk, is not capable of evaluating changes in trabecular architecture [4]. It is thought that trabecular measurement would allow better assessment of fracture risk [5]. Quantitative, non-invasive, radiation-free, in vivo analysis of trabecular bone structure in the central diaphysis of humans is currently impossible.

We have developed a new magnetic resonance based technique (hereafter non-invasive and radiation-free technique—MRTA) for structural analysis (MRTA) which provides unique structural information on trabecular structure in the central diaphysis through the application of a custom pulse sequence which can be added to a conventional MR scan. We have demonstrated in a preliminary study that MRTA [6]—measurements of trabecular structure correlate significantly with pT1 derived trabecular separation (Thsp) [7,8].

**Purpose**

To evaluate the utility of MRTA structure metric to assess the trabecular bone structure.

---

**Results**

In this clinical trial, structural waveform spectra showed peaks above the mean noise level in all orientations at the hip and spine. The most significant (p=0.0027) separation of individuals with healthy bone from those with abnormal trabecular bone structure was observed through analysis of the ratio of the highest intensity peaks in the waveform spectra from the spine (S1) to hips.

**Discussion**

Prior to this clinical study, MRTA was tested pre-clinically in rats and validated using micro-CT imaging [9]. Results showed that the ratio of the two highest intensity peaks within the structural waveform range in the structural waveform spectra was significantly different for bone derived using MRTA compared to a gold standard derived using micro-CT with Fiji software.

This clinical study represents the next steps of validating the new technique through clinical application to human subjects. A comparison of the ratio of the two highest intensity peaks within a similar structural waveform range was extracted from the structural waveform spectra for quantitatively measure the observed difference between spectra from normal, osteopenic and osteoporotic individuals. This metric showed significant (p=0.0052) correlation (r=0.64) to 

In the future, further evaluation of this new MRTA technique using ANOVA demonstrated its ability to significantly distinguish individuals with normal bone from those with some degree of bone loss.

A second clinical study is underway with the University of Arizona, Tucson under the direction of Dr. Deirdre Martin. Head of Radiology, to further refine the extracted biomarker and show greatest difference between normal and abnormal trabecular bone structure.

In summary, the results of this study indicate the suitability of MRTA for the determination of bone health, and the potential for long term, non-invasive monitoring of the trabecular microarchitecture without subjecting the individual to ionising radiation.

---

**References**