

Feasibility of Assessing Trabecular Structure Using a Standard Clinical MRI Scanner

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INTRODUCTION:

Dual energy x-ray absorptiometry (DXA) scans have become the gold standard for assessing bone health, however its inability to distinguish between cortical and trabecular bone means it is of limited clinical use in conditions where abnormal trabecular microarchitecture is responsible for adverse bone health [1, 2]. Several studies have been performed to develop high resolution MRI pulse sequences which allow quantification of trabecular bone parameters [e.g. 3, 4]. However, many of the sequences used in these studies are not routinely available on standard clinical scanners, and in some cases custom-made coils were used, which again are not routinely available. The purpose of this study was to assess the feasibility of performing high resolution MRI (micro MRI) using the standard scanner hardware and software available at our institution, and to determine whether this technique can be used to distinguish between healthy and diseased states of trabecular bone.

METHODS:

A TrueFISP pulse sequence was optimised for high resolution imaging using a 3T Siemens Verio scanner (Siemens Healthcare, Erlangen, Germany) with a Siemens CP Tx/Rx extremity coil (TE = 4.39ms, TR = 10.19ms, flip angle = 60°, NEX = 11, FOV = 100mm, matrix = 348×348, no. of slices = 30, total scan time = 10:06 minutes). Images were acquired from the proximal tibia of seven adults with Osteogenesis Imperfecta (M:F 3:4, age 21-45 years, median age 38 years) and seven adults with no known bone disease (M:F 3:4, age 20 – 45 years, median age 40 years), as illustrated in Figure 1, using the epiphyseal growth plate as a reference for positioning. Five volunteers also had a repeat scan on a different occasion to allow an assessment of reproducibility to be made. Acquired images were analysed and four key trabecular bone parameters - apparent bone volume/total volume ratio (appBV/TV), apparent trabecular thickness (appTb.Th), apparent trabecular number (appTb.N) and apparent trabecular spacing (appTb.Sp) – were quantified using in-house software developed in IDL (Research Systems Inc., Boulder, CO) using the method described by Majumdar et al [1]. Bone parameters from the Osteogenesis Imperfecta volunteers were compared to those obtained from healthy volunteers using the student's t-test of significance, and the coefficient of variation was used to assess the reproducibility of the method.

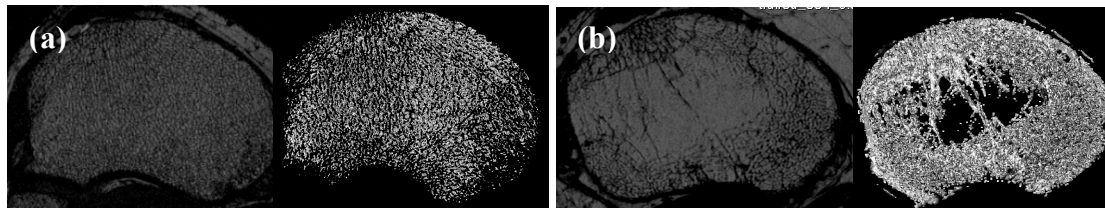


Figure 1: Micro MRI images and 3D binarized reconstructions from (a) a healthy volunteer and (b) a volunteer with Osteogenesis Imperfecta

RESULTS:

Volunteers with Osteogenesis Imperfecta were found to have a 42% reduction in appBV/TV ($p < 0.01$), a 37% reduction in appTb.N ($p < 0.01$) and a 47% increase in appTb.Sp ($p < 0.01$) when compared to healthy volunteers. There was no statistically significant difference in appTb.Th. Coefficients of variation for appBV/TV, appTb.Th, appTb.N and appTb.Sp were 5.8%, 6.0%, 5.6% and 7.0% respectively.

CONCLUSIONS:

Using patients with Osteogenesis Imperfecta as a positive control, we have shown that the existing clinical MRI facilities in our institution can successfully be used to discriminate between healthy and diseased states of trabecular bone using 3 key trabecular bone parameters: appBV/TV, appTb.N and appTb.Sp. The micro MRI technique has the potential to be used with other methods of densitometry to provide a more integrated assessment of bone health

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