

Feasibility of In Vivo 3-D MRI of Femoral Neck Bone Microarchitecture at 3 T

Gregory Chang¹, Ryan Brown¹, Graham C Wiggins¹, Chamith S Rajapakse², Stephen Honig³, and Ravinder R Regatte¹

¹Radiology, NYU Langone Medical Center, New York, NY, United States, ²Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, United States,

³Rheumatology, NYU Langone Medical Center, New York, NY, United States

Target Audience. Imaging scientists and radiologists involved in musculoskeletal disease research.

Purpose. The hip is the most devastating site of osteoporotic fracture and is also the anatomic site used to diagnose osteoporosis (via dual energy x-ray absorptiometry (DXA) estimation of areal bone mineral density). Deterioration of bone microarchitecture is included in the definition of osteoporosis and its in vivo assessment may aid in fracture prediction (1). In vivo imaging of bone microarchitecture of the hip, a deeper anatomic structure, is challenging due to limitations in resolution and signal-to-noise ratio (SNR) and has only been described once (2). Our purpose was to leverage advances in magnetic resonance imaging (MRI) coil technology (50 element receive array setup) and perform 3-D MRI of hip bone microarchitecture in vivo.

Methods. This study had institutional review board approval. On a 3 Tesla MRI scanner (Siemens Skyra, Erlangen, Germany), we used Kellman's method (3) to compare the signal-to-noise ratio for MRI of the hip using a 50 element radiofrequency receive array setup (18 channel body coil and 32 channel spine coil) and a 4 element radiofrequency receive array (body coil). We performed high-resolution MRI of five subjects with osteopenia or osteoporosis using a 3-D fast low angle shot sequence (TR/TE = 30 ms/4.92 ms, matrix = 512 x 512, field of view = 12 cm, slice thickness = 1.5 mm, acquisition time = 22 minutes 34 seconds).

Results. SNR maps reveal higher SNR both at the greater trochanter and femoral neck when using the 50 element radiofrequency receiver coil setup compared to the standard 4 element receiver array (Figure 1). With 50 radiofrequency elements, individual trabeculae within the femoral neck can be visualized, including compressive and tensile trabeculae described in anatomy textbooks (Figure 2). As expected, there is a paucity of trabeculae in the location of Ward's triangle. The entire proximal femur is imaged.

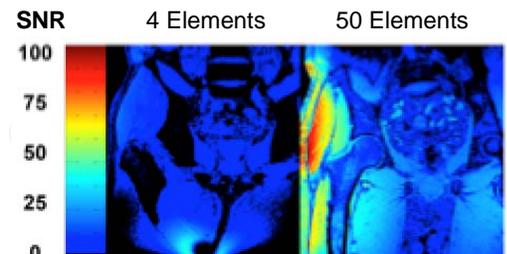


Figure 1. There is higher SNR for the hip when using the 50 element compared to the 4 element array.

Discussion. We demonstrate the feasibility of performing in vivo 3-D MRI of femoral neck bone microarchitecture in vivo using a 50 channel receive array setup at 3 T. Previously, this has been challenging due to limitations in SNR and resolution for imaging deep anatomic structures. For the first time, bone microarchitecture can be assessed in the same anatomic location as patients' routine clinical DXA exams.

Conclusion. This 3 T method may serve as a tool to study femoral neck bone microarchitectural alterations in osteoporosis or in response to interventions aimed at preserving bone strength (3).

References. 1. Wehrli et al. J Magn Reson Imaging 25, 390 (Feb 2007). 2. Krug et al. Osteoporos Int 16, 1307 (Nov, 2005). 3. Kellman et al. Magn Reson Med 54, 1439 (Dec, 2005).

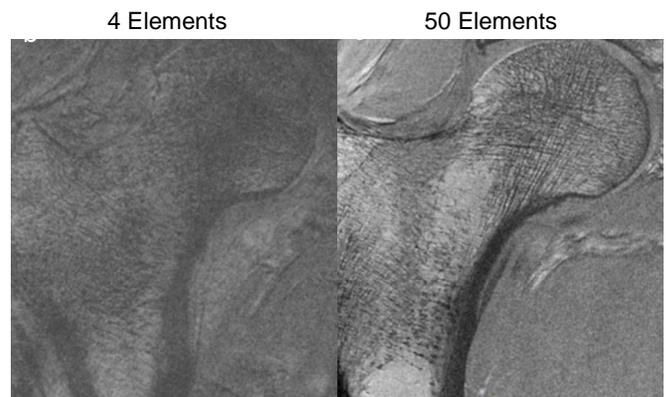


Figure 2. Trabeculae can be seen using 50 elements, but are difficult to visualize when using 4 elements.