Balanced SSFP Profile Asymmetries in Cartilage

N. Stikov¹, K.E. Keenan¹, K.L. Miller², J.K. Barral¹, G.E. Gold¹, J.M. Pauly¹
¹Stanford University, Stanford, CA USA, ²FMRIB Centre, Oxford University, Oxford, United Kingdom

INTRODUCTION:

Osteoarthritis of the knee affects approximately 30% of the American population over 60 [1]. Currently osteoarthritis cannot be detected until after significant degradation of cartilage. Detection of changes in glycosaminoglycan (GAG) content of cartilage may be useful for early diagnosis of osteoarthritis. The gagCEST contrast mechanism succeeds in imaging GAGs thanks to their asymmetric z-spectrum [2]. The asymmetric frequency distribution (lineshape) within a voxel should also contribute to an asymmetric balanced SSFP profile [3]. Such an asymmetry has recently been observed in the SSFP profile of white matter in the brain [4]. We used balanced SSFP to look for an asymmetry in cartilage.

RESULTS:

We scanned the tibia from one fresh-frozen female (age 67) cadaver on a 1.5T GE Excite system. We used a 3D balanced SSFP sequence and a 3-inch surface coil.

SCAN PROCEDURE

• 10cm FOV, 0.3 x 0.3 x 3mm resolution, TR = 10ms, TE = 5ms, Bandwidth ±64kHz. Total scan time 52 min

• Swept the SSFP profile from ±50Hz (TR = 10ms) with 1.5Hz resolution, by acquiring a series of 67 SSFP images with different RF phase increments ranging from −π to π. This frequency range spans the spectrum of GAG.

ANALYSIS

• Six ROIs (two in cartilage, bone, and saline water)

• For each ROI computed an asymmetry index AI = (hp − hn)/(hp + hn) where hp,n is the peak signal for positive and negative frequencies respectively [4]

DISCUSSION:

• The observed asymmetry in the cartilage SSFP profile complements the work of Ling et al. [2] which showed that the asymmetry in the z-spectrum of cartilage can be used to image glycosaminoglycans (GAGs)

• The balanced SSFP asymmetry is dependent on the orientation of the specimen (See oral presentation #866)

• Scan time can be reduced by using a stack-of-segmented EPI sequence [4]

CONCLUSIONS:

• The balanced SSFP profile asymmetry provides a novel method for imaging cartilage, which could serve as a sensitive marker of tissue microstructure.

• The differences in the general shape of the frequency profiles of cartilage (A, D), bone (B, E) and water (C, F) can be attributed to the different T1 and T2 parameters of the material, but the asymmetry in cartilage (A,D) is unique and cannot be explained by T1 and T2 alone

REFERENCES:


Contact: nikola@stanford.edu

See also:


Oral #866 (K. Miller et al: Balanced SSFP Profile Asymmetries are Sensitive to White Matter Tract Structure) at 11:18 on Friday in room 313BC