THE EFFECTS OF B1 INHOMOGENEITY CORRECTION FOR 3D-VARIABLE FLIP ANGLE T1 MEASUREMENTS IN HIP-DGEMRIC AT 3T AND 1.5T

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Introduction

3D Variable Flip Angle (3D-VFA) is a promising method for T1 quantification in delayed Gadolinium enhanced MRI of cartilage (dGEMRIC), which is a technique for molecular imaging of the proteoglycan level in cartilage by quantitative T1 measurements [1]. The 3D-VFA method is sensitive to variations in the transmitted B1 field and not until recently methods have been introduced to correct for such B1 inhomogeneities [2]. The aim of this work was to investigate the necessity of using such B1 correction for dGEMRIC measurements in a clinical protocol at both 1.5T and 3T.

Methods

Images from 30 hip patients, receiving dGEMRIC as part of their clinical care, were analyzed retrospectively. All scans were performed using 3D-VFA with B1 correction (MapIt, Siemens Medical Systems). 15 patients were imaged at 1.5T and 15 patients at 3T scanners (Siemens Medical Systems). All imaging was performed 30 minutes after intravenous administration of a double dose Gd-DTPA2^{-} (Magnevist®).

The B1 correction was achieved by using an additional sequence, where a spin echo and a stimulated echo is generated using a 90°-90°-90° RF pulsing scheme, from which the relative B1 field strength could be calculated in each voxel [3]. This calculated B1 value was then used for correction while calculating the T1 value from the 3D-VFA acquisition [2].

For 3D-VFA voxel size was 0.8x0.8x0.8 mm, matrix size 192x192x100, FoV 16 cm, TR 15 ms, TE 5 ms. Flip angles (FA) were 5° and 22° for 1.5T and 4° and 25° for 3T. For the B1 correction FoV was also 16 cm, with voxel size 15.6×15.6×5.0 mm for 1.5T and 4.7×4.7×10.0 mm for 3T. TR was 1000 ms. For each subject, T1 was calculated both with and without taking the B1 correction into account. The results were then statistically compared for both anterior and posterior regions of interest in a parasagittal slice parallel to the femoral neck axis (fig 1).

Results

The difference between T1 values calculated with and without taking the B1 correction into account is notably higher at 3T than at 1.5T (fig 2). The corresponding systematic errors are particularly notable since they are of opposite signs and about twice as high at 3T compared to 1.5T (table 1). However, also the random error differs, being twice as high at 3T compared to 1.5T and the Pearson correlation is lower at 3T than at 1.5T (table 1).

Fig. 1

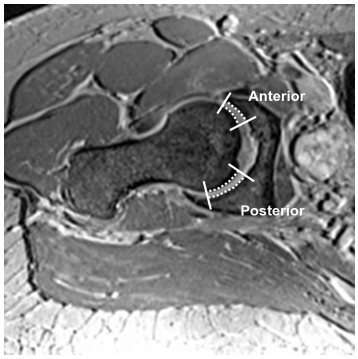


Fig. 2a 1.5 T

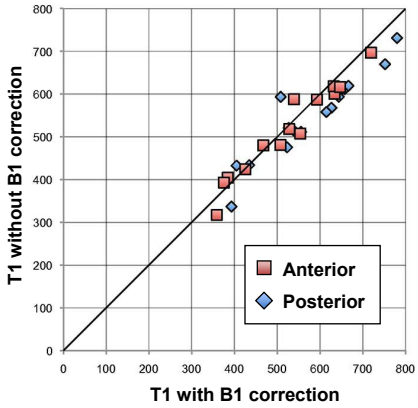
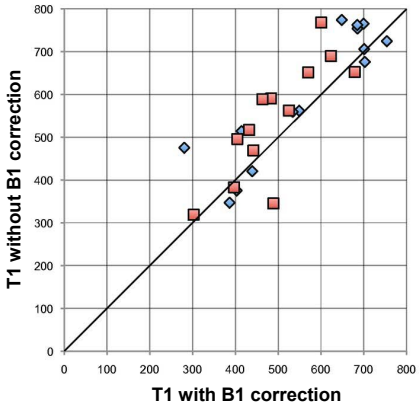


Fig. 2b 3 T



Discussion and conclusions

In general, B1 inhomogeneities in vivo are considered to increase as the magnetic field strength is increased. This is primarily related to the dielectrical and the conductive properties of the investigated object. The findings in this work are thus in line with these expectations, as the differences between T1 values measured with and without B1 correction are about twice as high at 3T as compared to 1.5T.

Table 1.	3T		1.5T	
	Anterior	**Posterior**	**Anterior**	**Posterior**
Pearson correlation	0.91	0.88	0.94	0.97
Systematic error	36.7 ms	52.5 ms	-30.5 ms	-11.1 ms
Random error (95%)	135 ms	155 ms	84.5 ms	53.1 ms

In conclusion, the findings in this work suggest that when performing dGEMRIC measurements using the 3D-VFA technique the variations in the B1 field should be considered, especially at 3T. In this particular study, the B1 variations are shown to be of minor influence at 1.5T and may thus in some carefully tested applications possibly be neglected.

References

1. Mamisch et al, MRM 60:768-773 (2008) 2. Wang et al, JMR 182:283-292 (2006) 3. Perman et al, MRM 9:16-24 (1989)