Discussion: Perfusion measurements using time-resolved 3D-MRI allow the assessment of regional perfusion abnormalities of the entire lung parenchyma. Using the three-dimensional visualization of the pulmonary perfusion parameters presented in this work the localization and of estimation of the size of perfusion deficits is facilitated. Furthermore, comparison of quantitative perfusion values between different lung regions and correlation with other imaging techniques such as CT is improved.

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Colour encoded multi-modal MRI as an aid to atherosclerotic plaque characterisation

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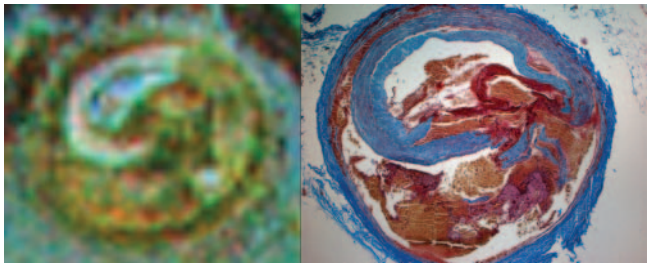
Introduction: Sudden rupture of the atherosclerotic plaque has become the leading cause of death in the developed world. The composition of the atherothrombotic plaque has been shown to play an important role in the risk of plaque rupture.

As a first step towards non-invasive plaque imaging using MRI, excised human plaques were imaged at 7 T (PharmaScan, Bruker Ettlingen). To facilitate the interpretation of images generated by acquisitions delivering several contrasts, a procedure involving artificial colour images has been established. These colour images were compared against histological staining.

Methods: Excised human plaques from several patients were imaged at 7 T with a resolution of 109x79x79 µm providing T1, T1 FatSat, T2 and PD contrasts. The individual histograms of the resulting 3D stacks of 256x256x256 pixels were adjusted to cap rare high and low pixel values. Afterwards the datasets were converted to 8-bit values and combined into a colour image.

Results:



The image shows the ColourMRI image (left) of a selected slice through a human internal mammary artery in comparison with histological staining. The T1 FatSat, PD and T2 contrasts were used in the red, green and blue colour channel respectively. The colour encoding is reproducible for samples from different patients. However, great care has to be taken not to change the sequence parameters.

Discussion / Conclusion: The method presented proved to be a simple, but very valuable tool in the characterisation of arterial plaque from human tissue samples. It is reproducible and compares very well with results from histological staining. This method should facilitate the understanding and presentation of in-vivo MR histology.

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Computerized medulla area calculation: methodology and application to Multiple Sclerosis

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Introduction: Axonal damage is present early in patients with Multiple Sclerosis (MS). An accurate computerized method to calculate the medulla area at C2 in T2-weighted MR images will probably define axonal loss if these patients compared to control subjects. We will define and evaluate a segmentation method based in histogram and brightness level differences between medulla and surrounding fluid.

Subjects and Methods: The method is based on the calculus of mean brightness level in the medulla area, and mean brightness of CSF within the thecal sac. Using these two levels (maximum for medulla and minimum for CSF), a break point providing a mask to segment medulla was calculated. Afterwards, the in-plane area was obtained.

In order to calculate the voxels with minimum (CSF) and maximum (medulla) values, a histogram analysis of the region of interest was obtained. Two masks that roughly include both zones, from the minimum to the maximum levels, were calculated. Finally, an image binarization according to a defined threshold between the minimum and maximum levels, provided a mask that delimitated the medulla. Due to the brightness level variations inside the medulla, a hole filling and a convex hull was done, obtaining the final mask used to calculate the area at C2. A ratio of area decrease was created [initial area initial / actual area].

Seventeen control subjects (7 males and 10 females), 18 patients with severe MS (8 males and 10 females), and 31 patients with less severe MS (14 males and 17 females) were studied with MR imaging (3 studies during 2 years). Mean age was 33 years (20-46 years).

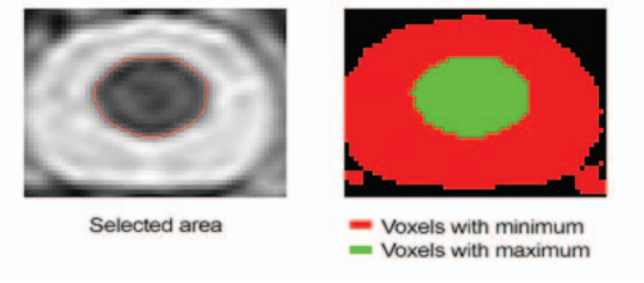

Figure 1: Selected area and histogram analysis of the region of interest.

Results: Measurements were fast and easily performed. The reproducibility of the results was high (less than 1%). A statistic analysis comapring the medias was perform using the t-Student test. There was a slight reduction of the medulla area in patients with MS throughout the time, the severity of atrophy being related to severity of disease. Control subjects measurements did not varied in the 2 years follow-up.

Conclusions: An accurate and reproducible method to calculate the medulla area in T2-weighted MR images was developed. Differences in the medulla area were observed between the 3 groups (normal controls, severe MS, less severe MS).

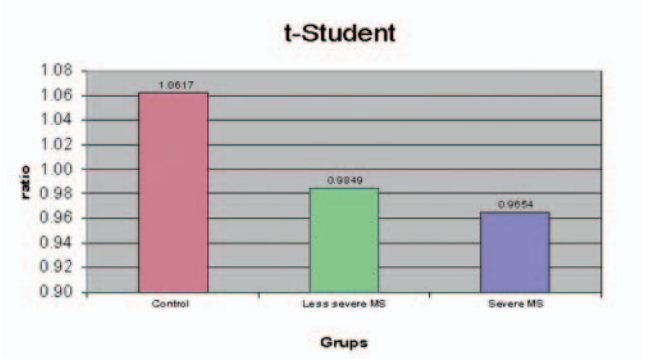

Figure 2: Statistic analysis using t-Student test.

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Comparison of spin echo distortion correction methods based on field map

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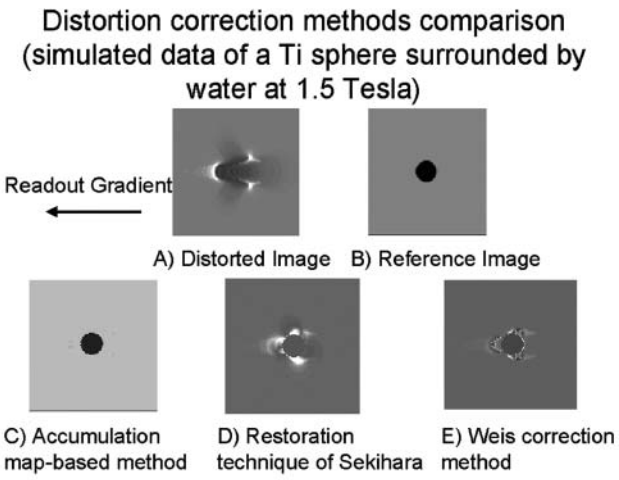
Introduction: MRI is a powerful imaging modality that offers a high tissue contrast. However, because of the magnetic susceptibility differences arising at air/tissue, metallic implant/tissue or contrast agents/tissue interfaces, the coding process is perturbed leading to geometrical and intensity distortions along the readout gradient for Spin Echo images. Those distortions increase with the main static field value. Different distortion correction methods based on a field map knowledge of the imaged object have been developed. In this paper we propose to compare them on data presenting different amount of distortions at different field values.

Method: Three methods are compared: the restoration technique proposed in [1], the correction method of Weis [2] and the Accumulation-Map method [3]. They differ from the mathematical modeling proposed for the distortion correction. Comparisons are performed on simulated and real data at 1.5T and 7T. For simulated data, a spherical object and a more complicated one (human brain) are used. In the human brain, a slice including sinuses and auditive cavities has been chosen. To obtain different amount of distortions, the sphere was surrounded by water and filled with air and Titanium, respectively. Real data are images of a cylindrical phantom obtained at 7T. Criteria used for the quantitative comparison are the root mean square error (RMSE) and the coefficient of variations (CV).



Results: For real data, the CV has been reduced by a factor of five after correction, for all tested methods meaning that for low distortions, correction was well performed. For important distortions, such as those induced by the Titanium sphere, the RMSE was reduced by a factor of three with the accumulation map-based method. For this object, the other methods have shown their limitations giving an RMSE after correction higher than before correction.

Discussion and Conclusion: Among the compared methods, the accumulation-map method gave the best results for low and important distortions. For the later, the other methods have shown their limitations. It is due to the mathematical modeling which is limited to a certain amount of distortion. One crucial point for the correction process is the field map. It is generally obtained from a phase map followed by a phase unwrapping step.

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Compensation for geometrical distortion in contrast enhanced whole-body MR Angiography

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Purpose: In contrast enhanced whole-body MR angiography (MRA) a patient's main arterial system can be imaged using an optimized MR sequence. This sequence scans the whole volume in only four stations by using a large field of view (450mm) and a small image overlap. Usage of a large field of view introduces significant hardware induced geometrical distortion to the acquired volume. The purpose of this study was to model this geometrical distortion and to create a non linear transformation which compensates for it in post processing.

Methods: A special MRA sequence was used on a 1.5T Philips Gyroscan Intera to acquire the volumes. A two dimensional phantom was constructed and used to image the distortion from this MRA sequence. Distortion symmetry was assumed in head - feet direction and rotational symmetry was assumed around the scanners main axis. The phantom was scanned with different orientations to give all distortion information needed. The geometrical