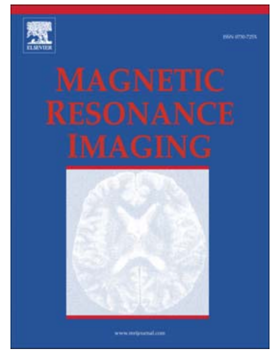

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Motion Correction for Diffusion Weighted SMS Imaging

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Introduction:

Diffusion-weighted imaging (DWI) is commonly used in clinical MRI, in particular in the assessment of stroke, demyelination, or cortical lesions [1], [2]. It also plays an important role in scientific studies of structural connectivity [3]–[5].

Although DWI sequences usually use fast readouts, such as echo-planar imaging (EPI), DWI scans commonly last several minutes, especially when used for diffusion tensor imaging (DTI). These long scans result in sensitivity to head motion [6], [7]. Motion correction with external optical tracking can improve DWI data quality [8]–[11]. However, affixation of tracking markers can be challenging and marker "slippage" during the scan will compromise the quality of motion correction or even introduce artifacts [12], [13].

Parallel imaging makes it possible to shorten the EPI readout for diffusion imaging [14], [15], and thereby reduce echo time (TE) or increase spatial resolution. However, this does not substantially reduce acquisition times, due to the rather long weighting gradients required for DWI combined with typically extensive slice packages, which results in prolonged repetition times, TR. In contrast, simultaneous multi-slice imaging (SMS) makes it possible to acquire several slices simultaneously [16]–[19] and can considerably shorten volume acquisition times for DTI protocols. However, this gain in scanning efficiency is often used to acquire more complex DWI protocols (such as multiple b-values, more diffusion directions, and higher resolution), reintroducing the problem of patient motion.

Motion correction for SMS-DWI can therefore be expected to improve DWI acquisitions. However, the effect of motion, including prospective motion correction (PMC), on SMS acquisitions and reconstructions, has not been investigated. Therefore, we incorporated prospective motion correction into diffusion weighted SMS imaging and investigated the influence of motion, motion correction, and relative coil motion on the reconstructed data. The algorithm described in [20] was extended to incorporate SMS reconstruction into multiplexed sensitivity encoding (MUSE) [21], [22]. Additionally, a technique was implemented to address potential marker slippage during prospective motion correction with external optical tracking, using intrinsic position information of the volumetric data.

Methods:

All experiments were conducted on a 3T Tim Trio system (Siemens Healthcare, Erlangen, Germany), using a 32 channel head-coil. External tracking was performed with an in-bore camera system (Metria Innovation Inc. Milwaukee, USA) [23]. Tracking markers were attached using double sided tape. A single spin-echo EPI sequence with diffusion weighting was modified to allow for continuous real-time position updates [9], SMS acquisition [18], [24], and acquisition in either single-shot or segmented mode. A