3D PROSPECTIVE MOTION CORRECTION SYSTEM (PROMO) IN PEDIATRIC POPULATION

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Introduction:
Artifacts caused by patient motion during scanning remains a serious problem in most MRI applications, with unsedated pediatric MR imaging being a notable example. Multiple approaches have been investigated in the past two decades in order to reduce motion artifact with varying success. Although these methods work sufficiently well for in-plane 2D motion, they do not adequately correct for through-plane motion that is often encountered in the clinical setting. The 3D PROspective MOtion correction system (PROMO) attempts to address the problem at its source by keeping the measurement coordinate system fixed with respect to the patient throughout the entire scan process (1). This results in both in-plane and through-plane motion correction with only a minimal increase in scan time. The goal of the project was to assess the improvements in the image quality in clinical setting quantitatively.

Methods:
Subjects: 9 pediatric subjects (mean age 10.75, range 9-12) were recruited for the study after being approved by our university’s Institutional Review Board. Pediatric subjects were instructed to "attempt to stay still throughout the study" with no further instruction.
Sequence: Images were obtained on 1.5-T Signa HDx system (GE Healthcare, Waukesha, WI) using an 8-channel phased-array head coil. Sets of 3 orthogonal low-flip, single-shot spiral acquisitions (S-Nav) were integrated with 3D Inversion-Recovery (IR) SPGR pulse sequences, as previously described (2). 4 series of 3D IR-SPGR sequences were obtained, 2 with 3D PROMO on and 2 off.
Subject motion quantification: In order to quantify motion, actual subject motion in the MR scanner was converted to a scalar representative value. Specifically, a measure of the total amount of subject motion was calculated from the mean of the norm of the subject position/pose estimates throughout the scan, with the initial pose vector set to all zeros at scan start.
Image motion quantification: Images were examined by a radiology physician, and motion was graded in all sagittal slices in each of the 4 series in the 9 subjects.

Results:
A repeated measures analysis of variance comparing the mean to root mean square of head motion estimates across the four scans (i.e., two PROMO on, two PROMO off) found no statistically significant difference. Mean image quality ratings by radiologist blinded to scan type showed a robust overall difference among the four scans (F=18.77, p<0.0001). Posthoc pair-wise comparisons revealed significantly lower image quality ratings for the pair of PROMO off (mean 2.52, STD 1.09) scans than the PROMO on (mean 1.1, STD 0.8) scans (p<0.01).

Conclusion:
This study demonstrates the effectiveness of 3D PROMO to detect and correct motion in pediatric subjects, and shows promise in providing clinically acceptable images in this and perhaps other "uncooperative" patient populations such as non-anesthetized, geriatric, trauma, or epilepsy patients.