T1-w SE-PROPELLER to overcome motion and flow artifacts in head and neck imaging

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Introduction

T1 weighted scans before and after Gadolinium (Gd) contrast administration are used for detection and staging of head and neck tumors. The classical Spin Echo (SE) or fast SE sequence with the standard line to line Fourier-encoding strategy has so far been the most widely used sequence in clinical protocols. However, motion artefact due to breathing and swallowing during data-acquisition are frequently encountered. In addition, phase-encoded flow artifacts are present and especially after post Gd contrast injection in patient studies. Recently, a new PROPELLER-based T1w Spin-Echo readout was introduced (1, 2, 3) to reduce the above mentioned artifacts. Our aim is to evaluate the performance of both sequences.

Materials and methods

10 volunteers and 2 patients have been enrolled to our study. The exams were performed on 3.0T Discovery MR750 scanners (GE Healthcare, Milwaukee, MI, USA) with DV24.0 software, using the standard head-neck coil array. Imaging parameters for the segmented T1w FSE scans were: FOV = 24x18 cm, slice thickness = 3 mm (gap 0.3), image matrix 448x320, NEX=2; TR/TE = 540/10ms, ETL=3, flip angle = 111° and receiver bandwidth = 36 kHz (scan time of 5min 55 s).

For T1w SE-PROPELLER, the blade was 320x32 lines, FOV = 24 cm, slice thickness = 4 mm, image matrix 320x320, TR/TE = 710/8 ms, NEX=1, ARC with acceleration factor =2 and receiver bandwidth = 50 kHz (scan time 4min 45s. For volunteers, two measurements scenarios were compared: with and without intentional cough and swallowing maneuvers. For the patient studies a post Gd T1w SE PROPELLER scan was compared to the post-contrast T1w FSE scan.

The severity of motion artefacts and flow artefacts was scored in both volunteers and patients as: (1) profound, non-diagnostic, (2) severe yet still diagnostic, (3) moderate, disturbing but diagnostic, (4) visible, non-disturbing, (5) imperceptible. Motion artefacts were scored on the T1w FSE and T1w SE PROPELLER images obtained during swallowing and coughing. Flow artefacts were scored on the images without intentional cough and swallowing maneuvers.

Results

Figure 1 shows scans in a volunteer demonstrating the effects of motion between T1w FSE and T1w SE PROPELLER. A clear reduction in motion artefacts with increased diagnostic quality is noted with T1w SE PROPELLER. The average score of motion artefacts on the volunteer portion of the study was 2.1 (range 1-4 and 3.8 (range 3-4) for conventional and PROPELLER acquisition, respectively Figure 2 illustrate the flow artifact reduction in two volunteers with both acquisitions. Flow artefacts are caused by both arterial and venous flow leading to a reduction in diagnostic quality on T1w FSE.

The average score of flow artefacts among volunteers was 2.4 (range 1-4) and 4.2 (range 3-5) for T1w FSE and T1 SE PROPELLER, respectively. Ghosting artifacts show as an increase in radial artifacts around the vessel lumen. However, these artifacts do not interfere and the scans can be considered of good diagnostic quality. Figure 3 shows an example of a patient after contrast administration. Arterial and venous flow artifacts reduction is clear on T1 SE PROPELLER.

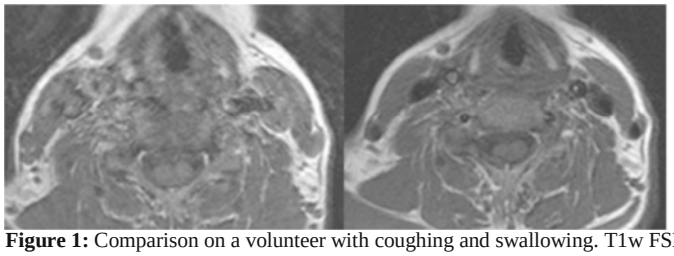

Figure 1: Comparison on a volunteer with coughing and swallowing. T1w FSE has severe motion and distinctive flow artifacts as well (left image). T1w SE PROPELLER shows a large artifact reduction (right image).

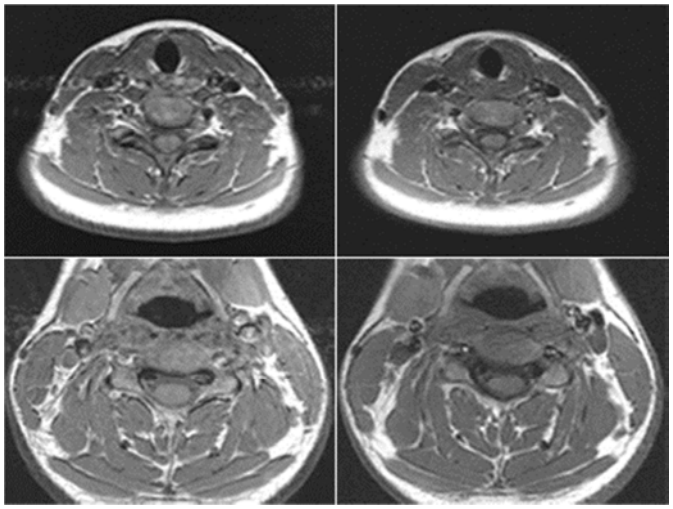

Figure 2: Ghosting artefacts from arterial and venous flow are present on T1 FSE (left images) but distributed radially in T1 SE PROPELLER (right images). Diagnostic quality is not impacted for the T1 SE PROPELLER acquisition.

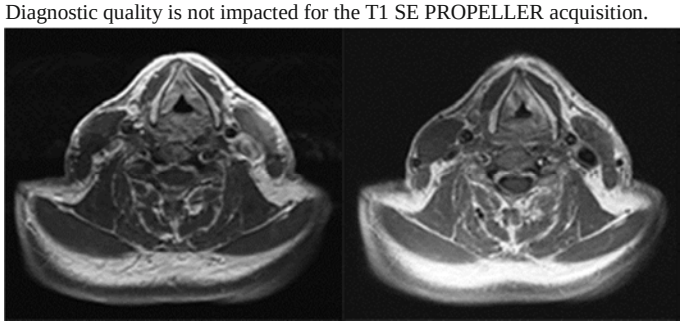

Figure 3: 3T post Gd T1w data of one patients. Left: Conventional SE with flow artifacts and a hyper intense signal in the Jugular vein. Right: SE PROPELLER without flow artifact and a hypo intense signal in the Jugular vein.

Discussion

Previous studies have shown that T1w SE POPELLER is helpful in the reduction of flow artefacts in the brain, especially in the T1w images post-Gd. An additional advantage of SE-PROPELLER sequence is the possibility to reduce bulk motion artefacts (such as rotation and translation). In this study, the effects of the PROPELLER readout are evaluated in the neck region in patients with head and neck tumors, which is usually degraded by motion (head motion, swallowing and coughing) and flow artefacts. In this work we have shown that with T1w SE-PROPELLER, motion artefacts can be reduced significantly. Flow artefacts in both pre and post T1w scan which reduces the accurate evaluation of head and neck tumors, are also minimized in the SE PROPELLER. PROPELLER related artifacts, such as streaks from vessels are encountered. But not influencing diagnostic quality

Conclusion In summary, motion and flow artefacts in the head and neck region can be reduced with SE-PROPELLER imaging.

References [1] Takei N, Tsukamoto T.; p. 1728. ISMRM-ESMRMB; 2007; Berlin, Germany. [2] Holmes JH. et. al.; p. 2333. ISMRM-ESMRMB; 2010; Stockholm, Sweden. [3] Skare, S, et al. p.3697. ISMRM 2013, Salt Lake City, UT