

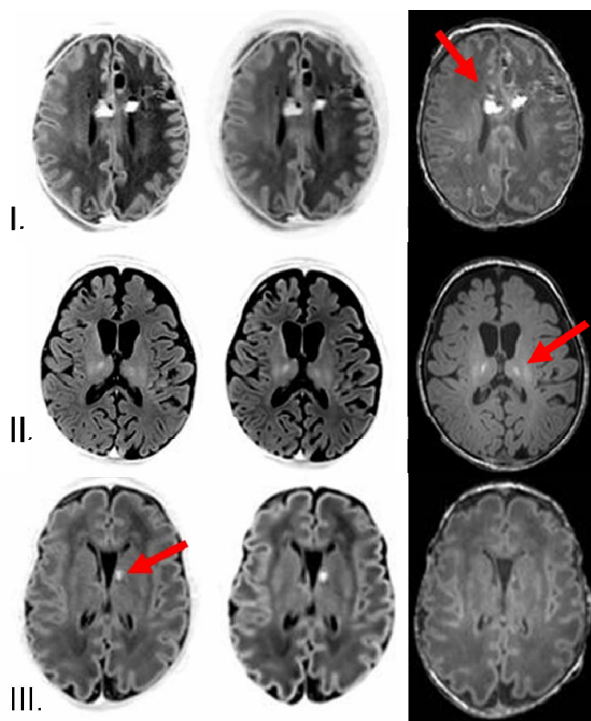
EVALUATION OF NEONATAL PATHOLOGY USING T1 WEIGHTED TECHNIQUES, SNAPIR AND GRADIENT ECHO

A. K. McGuinness¹, C. Malamateniou¹, J. M. Allsop¹, S. J. Counsell¹, R. G. Nunes¹, Z. Q. Wu¹, N. Tusor², A. Ederies², J. V. Hajnal¹, and M. A. Rutherford¹

¹Imaging Sciences Department, MRC Clinical Sciences Centre, Hammersmith Hospital, Imperial College London, London, United Kingdom, ²Neonatal Imaging Group, Hammersmith Hospital, Imperial College London, London, United Kingdom

Background: Snapshot Inversion Recovery (SNAPIR), an optimized single-shot T1-weighted acquisition, has effectively improved normal brain anatomy delineation in cases of fetal motion compared to the standard T1-weighted gradient echo protocol¹. However the role of SNAPIR in neonatal imaging where motion may also be an issue has not yet been established. The aim of this study was to prospectively evaluate and compare neonatal brain pathology delineation as depicted by the SNAPIR approach, with and without Snapshot to Volume Reconstruction (SVR)² and a standard T1-weighted gradient echo multi-shot volume acquisition (MP-RAGE).

Methods: Research ethics committee approval and prior informed consent was obtained from the parents of all infants. Imaging was performed on a 3.0 Tesla scanner (Achieva; Philips Medical Systems, Best, the Netherlands) with an 8 channel SENSE head coil for various clinical indications. 18 term and preterm infants born at a median (range) gestational age of 39 (26-42) weeks and scanned at a median (range) post-menstrual age of 42 (28-49) weeks were prospectively imaged using the following protocols: 1) a standard MP-RAGE acquisition acquired in the sagittal plane and reconstructed in the axial plane (Acquired resolution 0.82x0.97x1mm³ in 6.5 min) and 2) the oversampled 2D SNAPIR sequence in the axial plane (Acquired resolution 0.98x0.97x2 mm³ in 6.5min). The SNAPIR datasets were then reconstructed into 3D using the SVR algorithm². The 3D MR-RAGE and SNAPIR volumes were reconstructed to 0.83mm³ and the 2D SNAPIR to 0.83mm² in plane resolution. The MRI scans revealed various brain pathologies: Haemorrhage (including subdural and parenchymal) (n=3), germinal matrix haemorrhage (n=1), cortical highlighting (n=3), punctate lesions (n=1), myelin abnormalities in the posterior limb of the internal capsule (PLIC) (n=2), white matter signal intensity changes (including diffuse excessive high signal intensity or DEHSI) (n=7), basal ganglia and thalami (BGT) signal intensity changes (n=5), anatomical dysplasias (n=3) and ventriculomegaly (n=4). Additionally the appearance of myelin in the PLIC and delineation of the pituitary were assessed separately. All images (MP-RAGE and SNAPIR with and without SVR) were evaluated using the MP-RAGE acquisition as the reference and a four point rating system for brain pathology delineation where 0=no detected pathology, 1=improved delineation of pathology with MP-RAGE, 2=pathology equally detected with both protocols, 3=better delineation of pathology with SNAPIR. Analysis was performed by a blinded experienced observer (MR). Ratings of zero (0) were excluded from further statistical analysis and average rating scores were then computed per pathology; the results were rounded-up to the nearest integer to evaluate the best imaging protocol for specific pathology delineation.



Results: Of the total 36 sequence acquisitions, 4 acquisitions in different infants were affected by motion artefact, 2 in the MP-RAGE and 2 in the SNAPIR sequence. All pathologies detected on the MP-RAGE were identified on the SNAPIR. The MP-RAGE was better than SNAPIR for detecting some punctate white matter lesions and SNAPIR was superior to MP-RAGE in one case of germinal matrix haemorrhage. In all other pathologies delineation was comparable between the two protocols. Delineation of brain pathologies was similar when the SVR reconstruction was applied to SNAPIR datasets (p=0.99). The internal cerebral veins were better delineated in SNAPIR with higher signal intensity compared to MP-RAGE but the pituitary was better visualized with MP-RAGE. Finally the appearance of myelin at the PLIC was poorer with SNAPIR when this was not used in combination with the SVR algorithm.

Figure 1: Demonstrating pathology delineation in, from left to right, the 2D SNAPIR, 3D SNAPIR following SVR and 3D MP-RAGE. Identification of subdural and parenchymal haemorrhage was similar between protocols in subject i. The established BGT lesions in ii. (infant aged 55 days) were better delineated using the MP-RAGE technique. Early BGT abnormal signal intensities were detected equally using both techniques. The germinal matrix haemorrhage in iii. was better demonstrated using the SNAPIR protocol.

Discussion: These results provide confidence that when conventional multishot techniques are degraded by motion artefact, SNAPIR can be used to detect a variety of pathologies in the neonatal brain. An increase in sample size could provide further insight into the reasons for the decrease in signal intensity of some short T1 lesions and structures noted in this pilot study. The application of SVR to the acquired SNAPIR data provides images in all three planes and generates volumetric datasets compatible with quantitative analysis, even in the presence of motion. The improved visualisation of myelin within the PLIC is useful as its appearance is a powerful indicator of later motor outcome in acquired injuries.

Conclusion: This study investigates the competence of SNAPIR, a rapid single shot

T1 weighted pulse sequence, in delineating pathology in neonates compared to a widely used gradient echo technique. The application of SNAPIR allows comparative delineation of numerous pathologies in neonates and is a robust technique for application when motion degrades MP-RAGE protocols.

References:

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2. Jiang, S. *et al. IEEE Trans Medical Imaging* 26(7), 967-980 (2007)