

### 3-T high b-value 1000 to 10000 s/mm<sup>2</sup> diffusion weighted MR imaging in healthy volunteers

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#### Introduction

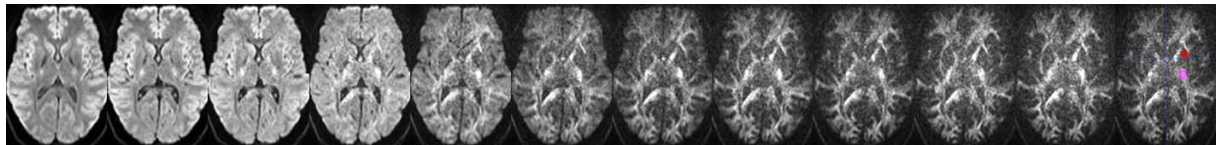
Diffusion weighted imaging (DWI) is the most sensitive imaging method to diagnose ischemic stroke. Furthermore, it is increasingly applied in the whole field of diagnostic imaging. Regarding neuroimaging, especially in stroke, b-values are applied in the clinical routine ranging from 0 to 1000 s/mm<sup>2</sup>. In an experimental setting b-values up to 5000 s/mm<sup>2</sup> were evaluated with promising results [1,2]. The newest generation of MR-scanners with higher gradient strength (e.g. 80 mT/m compared to 40 mT/m in previous studies) are able to further increase b-values with still reasonable SNR. In this study, we evaluated applicability of b-values from 1000 to 10000 s/mm<sup>2</sup> in a cohort of healthy volunteers regarding SNR and overall image quality using a 3T MR-scanner with a gradient strength of 80 mT/m.

#### Methods

For this trial approved by the local ethics board, 10 healthy volunteers (4 men, 6 women; mean age 34y range 28-46) were scanned on a 3T (MR Prisma, Siemens Medical, Germany, gradient strength: 80 mT/m) body scanner with a 64 channel head-coil. Eleven different DWI scans (TR 14500 ms, TE 90 ms 1.6x1.6x3.0 mm 40 slices) with b-values ranging from 1000 s/mm<sup>2</sup> to 10000 s/mm<sup>2</sup> in steps of 500 s/mm<sup>2</sup> (between 1000 s/mm<sup>2</sup> and 2000 s/mm<sup>2</sup>) and steps of 1000 s/mm<sup>2</sup> (2000-10000 s/mm<sup>2</sup>) were applied. The scanning protocol also included a standard FLAIR sequence and a T1 weighted 3D MPRAGE scan. Post processing of the images was performed with MRicron [3] and FSL [4]. All images were aligned to the DWI images with b=1000 s/mm<sup>2</sup>. ROIs were drawn in both hemispheres in the following regions: hand knob, putamen, thalamus pyramidal tract, brainstem, cerebellum using ITK-Snap [5]. Additionally a ROI outside the brain was defined to measure image noise. SNR was calculated for all ROI.

#### Results

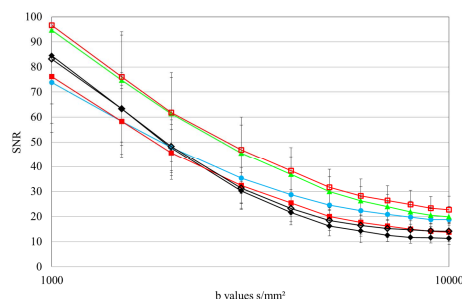
Representative DWI images of one subject are shown in Figure 1. The mean SNR for the ten volunteers are shown in Figure 2 for the different structures. The SNR values decrease exponentially. The SNR of the pyramidal tract and the ROI in the hand knob (red lines) continue parallel to each other. The SNR of the putamen and thalamus (black diamonds) drops after a b value of 2000 s/mm<sup>2</sup> more than the SNR of the other structures.



**Fig. 1:** The first eleven pictures show for one volunteer the different b-values from 1000 s/mm<sup>2</sup> to 10000 s/mm<sup>2</sup> in steps of 500 s/mm<sup>2</sup> (1000-2000 s/mm<sup>2</sup>) and 1000 s/mm<sup>2</sup> (2000-10000 s/mm<sup>2</sup>) respectively. In the last picture as an example (b-value of 8000 s/mm<sup>2</sup>) the ROI of putamen and pyramidal tract are displayed.

#### Discussion

In this work we were able to demonstrate that diffusion weighted imaging with b-values up to 10000 s/mm<sup>2</sup> with still reasonable SNR can be achieved with high gradient-strength MR-scanners. The decreasing signal with increasing b-values is in good accordance with values shown in previous studies for maximum b-values of 5000 s/mm<sup>2</sup> [1,2]. Interestingly the b-values of grey matter structures drop more pronounced with increasing b-values as compared to white matter or mixed brain tissue, which may be exploited as additional diagnostic information. This is shown in Figure 2: the signal decrease of thalamus and putamen compared to the other voxels with preferentially white matter is much higher.



**Fig. 2:** Mean SNR for six different brain tissues and eleven different b-values from 1000 to 10000 s/mm<sup>2</sup>. Black filled diamond putamen, black unfilled diamond thalamus, blue circle brainstem, green triangle cerebellum, red filled square hand knob and red unfilled square pyramidal tract. Error bars define standard deviation.

#### References

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