Diffusion weighted imaging of the kidneys in freely breathing infants using multidirectional scanning

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Purpose

Diffusion weighted imaging (DWI) can provide information on both function and morphology of the kidneys, but its clinical use has until now been limited due to its high sensitivity to respiratory motion giving rise to artefacts and low image quality (1, 2). The motion compensation methods used today are limited by scan time and are impracticable in some patients. Free breathing DWI scanning with signal averaging has therefore been proposed for body imaging (3). Multidirectional DWI scanning with less diffusion weighting in the primary direction of respiratory motion may improve image quality by reducing motion artefacts. The objective of the study was to compare image quality and ADC values for conventional DWI (cDWI), tetrahedral DWI (tDWI) and diffusion tensor imaging (DTI).

Methods

13 infants (age 0-6 months) with pyelonephritis were scanned during free breathing without sedation using (cDWI), (tDWI) and (DTI). In all DWI methods, coronar SS-EPI was performed with a 1.5T scanner, TR=2000ms (cDWI), TE=66ms, acceleration factor=2, b=0 and 700 s/mm² with 3 (cDWI), 4 (tDWI) and 24 (DTI) different diffusion directions, but an equal number of total diffusion measurements, *i.e.* NEX=8, 6 and 1 times for cDWI, tDWI and DTI, respectively.
For calculation of SNR and ADC, ROIs were manually drawn in both kidneys and in the background of all images. The decrease in SNR (SNR_{b0}- SNR_{b700})/SNR_{b0} and ADC values were calculated and compared for the methods. Statistical analyses were performed with the Wilcoxon signed rank test.

Results

The decrease in SNR was lower for DTI (0.36±0.11SD) as compared for cDWI (0.52± 0.08; $p<0.05$) and tDWI (0.54±0.1; $p<0.05$) (Fig 1) resulting in higher visibility of lesion areas in the infants (Fig 2). However there was no significant difference for tDWI compared to cDWI ($p=0.08$). There was no significant difference between the ADC values for cDWI (1.48±0.08), tDWI (1.50±0.09) or DTI (1.50±0.14).

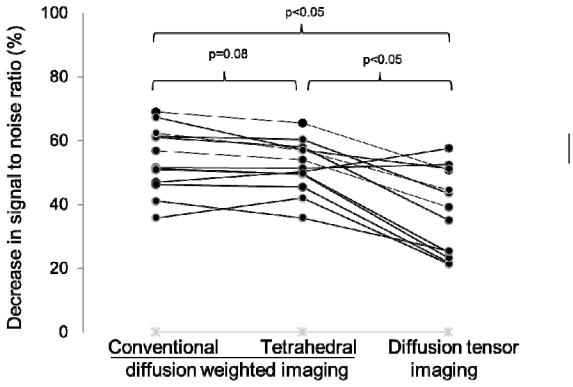

Fig 1. Data for 13 infants examined with conventional diffusion weighted imaging (cDWI), tetrahedral diffusion weighted imaging (tDWI) and diffusion tensor imaging (DTI). The mean decrease in signal to noise ratio (SNR) is significantly lower for DTI than for cDWI or tDWI, indicating higher image quality in DTI.

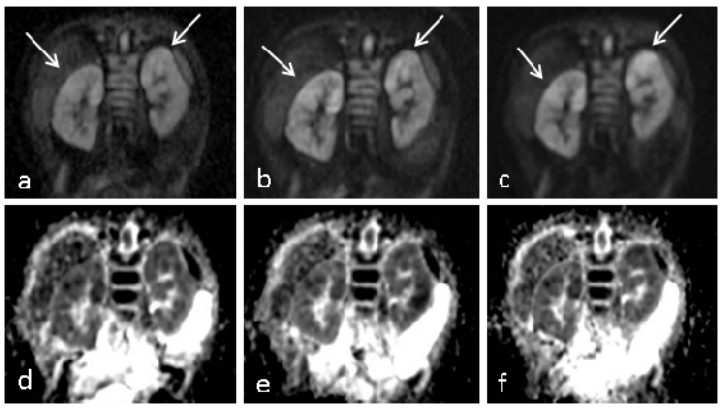

Fig 2. Diffusion weighted images of an infant with bilateral pyelonephritic lesions (arrows). Coronar DWI with b=700 s/mm² (a-c) and ADC maps (d-f) acquired with cDWI (a,d), tDWI (b,e) and DTI (c,f) sequences. The high signal pyelonephritic lesion areas with corresponding low ADC areas are best visualized in DTI (c,f) that is less noise vitiated compared to cDWI and tDWI images.

Discussion and Conclusion

This study indicates that the image quality in multidirectional DWI with DTI is superior to conventional and tetrahedral DWI in renal imaging in infants. This may be due to less sensitivity to breathing motion artefacts and enhancement of the anisotropic nature of the kidney. Hence, multidirectional DWI has a potential to be a valuable tool for abdominal DWI imaging in freely breathing patients that are uncooperative during scanning.

References

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