Optimisation of fast quantitative T2 imaging of the premature brain: a fantom study

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Introduction:

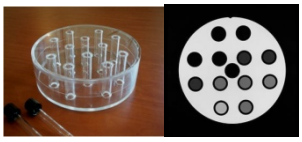
The assessment of myelination progress is a major purpose of newborn brain imaging. Some studies proved that the reduction of the T2 relaxation time of white matter reflects the progress of myelination. However, to our knowledge no study has yet investigate quantitative T2 map sequences used in pediatric neurology.

Aim:

The aim of this work was to optimize and compare the different T2 map sequences on premature newborn so we could find one suitable for clinical routine brain maturation study (i.e. exam without any sedation).

Material & methods

All the images were acquired on a 1.5T Signa HDx MRI device (GE, Milwaukee, USA) with 8 elements head coil. Four sequences (4 echoes SE, SSFSE, ASSET, T2-MAP, see table1) were tested on test object (Eurospin TO1, Spin Safety, France) containing MnCl2 solutions (cf picture1). For each sequence validity and long term reproducibility was studied and compare to the SE sequence used as standard.



Picture1: Test object used and resulting image

Sequence	SE	SSFSE	ASSET	T2 4 echoes	T2 MAP™
Echo(es) per sequence	1	1	2	4	8
Number of series acquired	19	14	4	1	1
Number of echoes collected	19x1	14x1	4x2	1x4	1x8
TE (ms)	20-40-60-80-120-160-200-240-280-320-360-400-450-500-550-600-650-900-1200	63-70-77-119-162-197-239-281-323-358-400-499-597-702	(44-144) (55-177) (77-221) (100-265)	(80-160-240-320)	(8,6-17,3-25 ,9-34,6-43,2-51,9-60,5-69,2)*
TR (ms)	6000	6000	6000	3000	3000
Number of excitations	1	0,53*	1	1	1
FOV (cm)	24	24	24	24	24
Matrix	256x256	256x256	320x256	256x192	256x192
Slice thickness (mm)	10	10	10	10	10
Spacing (mm)	10	10	10	10	10
Echo train Lenght	1	1	24	1	1
Acquisition duration	26min48s	<1s	1min18s	13min24s	12min54s

Table1 :Summary of used sequences

Post-processing (echoes, maps) was achieved with the ImageJ software (http://rsbweb.nih.gov/ij/).

Results:

Each of the four sequences allowed reproducible estimation of T2. After mathematical correction, T2 values found for each sequence were comparable to those calculated by the reference sequence (see example for SSFSE sequence on figure 1).

The major argument that leaded us to keep the SSFSE sequence for premature newborns T2 maps was its duration (600 ms each echo/slice). This particular sequence was optimized in order to decrease final acquisition time. Long time reproducibility has also been evaluated. Chosen echo times (number, value) based on their influence on the resulting map are 120, 200, 280 and 360 ms.

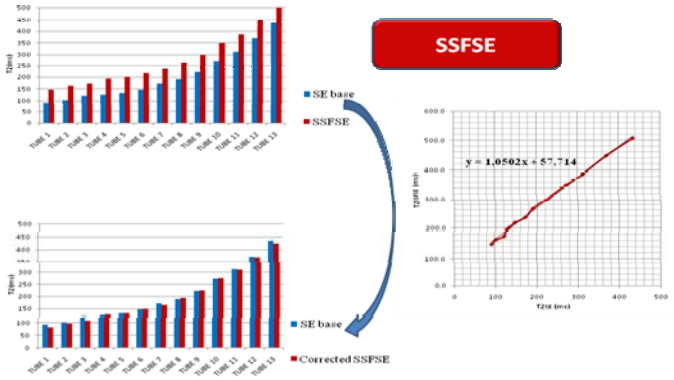


Figure1 : comparison of SSFSE sequence to SE before and after mathematical correction

Conclusion:

This work allowed us to create a sequence, SSFSE 4 echoes, reliable and reproducible to calculate T2 maps of premature brains with a duration suitable for routine clinical practice (without any sedation), with any standard coil (no parallel imaging needed). Due to its duration, nearly all examination are performed without movement artifacts.

As we investigate all premature newborns (<33weeks gestational age), this sequence is therefore included in the imaging protocol. It will be also useful to access brain myelination in a next research protocol.

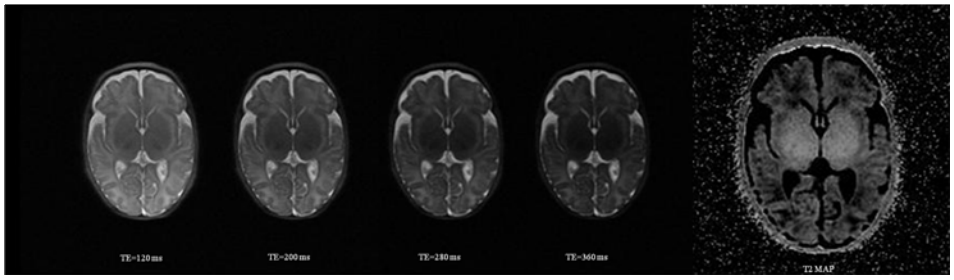


Figure2 : application of the 4 echoes SSFSE sequence and resulting T2 map