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RESULTS – Susceptibility maps provided additional information not obtained from conventional MR sequences in all of the 14 cases, in which either hemorrhage, calcification, or both were found. Three cases are presented here exemplarily. Patient A (male, 7 yrs 10 mos) suffered from tuberous sclerosis (Bourneville-Pringle disease, OMIM 191100) (Fig. 1), an inherited disease, characteristically showing subependymal nodules and dysplastic areas of the pallium (tubera), both of which may calcify. The FLAIR sequence showed hypointense lesions adjacent to both the caudate nuclei and the right trigonum. Further characterization of the lesions was not possible on the standard clinical MR contrasts (Fig. 1a, b). The conspicuous areas appeared strongly hypointense on the susceptibility map, indicating clearly substantial calcification. The structure of the lesions was much better delineated with QSM and few additional small calcifications were identified (arrows in Fig. 1c; mean magnetic suscep-
tibilities between -0.3 and -0.15 ppm). Since tubera, sometimes not detectable with conventional MRI sequences, can be sources of seizures, detection of each tuber is important. Patient B (male, 10 yrs 2 mos) suffered from spontaneous bleeding of the right basal ganglia (straight arrows in Fig. 2). The hemorrhage was seen on the conven-
tional MR images as a hypointense rim and an iso-
to hypointense center on both T-
weighted (Fig. 2a) and GRE magnitude images (Fig. 2b). In addition, a subventricular clot (squared-ended arrows in Fig. 2) and intraventricular blood sedimentsations (circle-ended arrows in Fig. 2) were identified on the GRE magnitude image (Fig. 2b). All lesions appeared hypointense on the susceptibility maps, confirming the presence of blood products. Interestingly, the hemorrhage of the basal ganglia was much more paramagnetic in the center (mean 1.1 ppm) compared to the periphery (mean 0.17 ppm), indicating resorption of blood products. The hypointense rim demarcating the bleeding represents an artifact, which can be explained by the strong field gradient in the vicinity of the lesion. Patient C (male, 2 yrs 7 mos) suffered a severe traumatic brain injury after a fall from 6 m height. In this case, MRI was performed 6 months and 12 months after the initial injury. The susceptibility maps of both examinations (Fig. 3a, b) delineated several smaller blood collections (circle-ended arrow; mean susceptibility 0.3 ppm) and calcifications (straight arrows; mean susceptibility -0.35 ppm) of and adjacent to the dura mater. The largest, yet discrete, calcification was confirmed on CT (107 Hoursfield units (HU); Fig. 3c), performed six weeks after the traumatic event. While the dura appeared both isointense and slightly hypointense on the susceptibility map in the initial MRI (squared-ended arrow in Fig. 3a), it showed hypointense signal on the susceptibility map acquired six months later (squared-ended arrow in Fig. 3b), indicating calcification of the dura and, thus, incomplete blood removal.

DISCUSSION – The presented clinical study clearly illustrates the potential of Quantitative Susceptibility Mapping (QSM) in pediatric neuroradiology, even at 1.5 T. Due to its high specificity, in particular with regard to differentiating between calcium and blood deposits, QSM represents a major addition to the neuroimaging toolbox with several important implications for routine applications. First, this new method is able to detect even minute hemmorages and smallest calcifications, due to its intrinsic sensitivity. Moreover, acquisition of thin (1-2 mm) slices is not degraded to its high specificity, in particular with regard to differen-
tiating potential of this novel imaging technique.