Value of susceptibility-weighted imaging for diagnosing intracranial hemorrhage in neonates according to anatomic location

T. Niwa[1], T. Takahara[1], T. Kwee[1], M. Benders[2], L. de Vries[2], V. O. Boer[1], F. Visser[1], P. R. Luijten[1], and F. Groenendaal[2]
[1]Radiology, University Medical Center Utrecht, Utrecht, Netherlands, [2]Neonatology, Wilhelmina Children's Hospital/University Medical Center Utrecht, Utrecht, Netherlands

Introduction

Intracranial hemorrhage is common in neonates, especially in preterm neonates. Different types of hemorrhage have been diagnosed in neonates including germinal matrix hemorrhage, intraventricular hemorrhage, intraparenchymal hemorrhage, venous lesions or extra-axial hemorrhage with various etiologies such as asphyxia, premature delivery and assisted vaginal delivery. Susceptibility-weighted imaging (SWI) is a technique that is highly sensitive for the visualization of substances with a magnetic susceptibility different from brain tissue such as blood, iron, calcification and air [1,2]. Despite recent increasing recognition of the clinical utilities of SWI, the role in neonates has not been well established. The purpose of this study was to assess the additional value of SWI for detecting hemorrhage in neonates according to anatomic location.

Subjects and Methods

Thirty five consecutive neonates (gestational age, 26 weeks to term neonates; corrected age 30 weeks to term equivalent age) who underwent a 3-T MRI examination were included in this study. Since it is important to keep the scan time as short as possible to minimize the chance on motion artifacts in neonatal imaging, multishot echo-planar imaging was employed in the SWI sequence. The sequence parameters were as follows: TR/TE of 52/30 ms, SENSE factor of 1.7, EPI factor of 3, slice thickness of 2 mm, 40 slices, scan time of 2 minutes and 33 seconds. Postprocessing was done with the method previously described [2]. T1- and T2-weighted images (T1 and T2WI) and SWI were retrospectively assessed for the presence or absence of intracranial hemorrhage. Two experienced radiologists independently rated the images regarding the detection of hemorrhage using a five point scale; 4: definitely hemorrhage, 3: probably hemorrhage, 2: equivocal, 1: no hemorrhage, 0: imaging evaluation impossible due to artifact. In the first reading session T1 and T2WI were assessed; in the second reading session both T1and T2WI as well as SWI were assessed. This evaluation was done according to the following anatomic locations; subependymal, intraventricular, intraparenchymal (cerebral hemisphere, cerebellum, and other portion), subpial/subarachnoidal, and subdural portions. We evaluated increased certainty of hemorrhage by adding the SWI. "Positive" increased certainty was defined as the score changed from 2 to 3 or 4, and "negative" increased certainty was defined as the score changed from 2 to 1. Detectability of hemorrhage for each combination of images was determined using Wilcoxon tests.

Results

The numbers of patients for positive increased certainty were (for observer 1 and 2, respectively): subependymal, 2/0; intraventricular, 3/1; intraparenchymal, 2/1; subpial/subarachnoid, 0/0; subdural, 0/0. The numbers of patients for negative increased certainty were (for observer 1 and 2, respectively): subependymal, 2/2; intraventricular, 2/1; intraparenchymal, 6/5; subpial/subarachnoid, 0/1; subdural, 0/0. The intraparenchymal portion was the most frequent location that was scored as 2 (equivocal) on T1 and T2WI that was most frequently changed by SWI findings (Figure 1). Scores regarding the detection of intraventricular hemorrhage of MRI with SWI were significantly higher than those of MRI without SWI ($p<0.01$ for each reader, Figure 2).

Figure 1.
MR images in a neonate (gestational week, 30; scan at term equivalent age) in whom ultrasound (not shown) showed persistent periventricular flaring and suspicious cysts. Small foci of hypersignal on T1-weighted image (a) and hyposignal on T2-weighted image (b) can be seen (arrows), which were scored as 2 (equivocal). However, SWI shows no signal loss that would suggest hemorrhage (c).

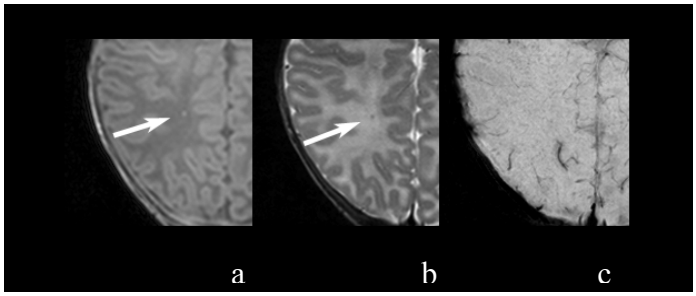
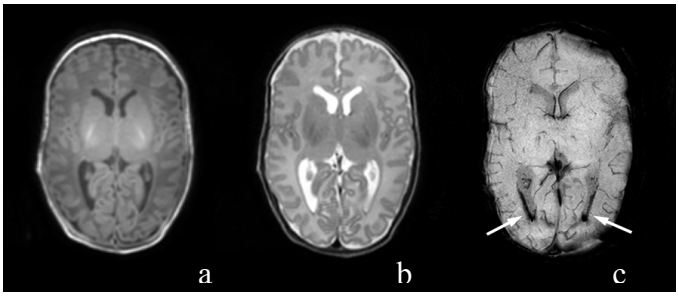


Figure 2.
MR images of a neonate (gestational week, 26; scan at term equivalent age) with germinal matrix and intraventricular hemorrhage. Intraventricular hemorrhage is unclear on T1- (a) and T2-(b) weighted images, while SWI clearly shows signal loss (c, arrows).



Discussion and Conclusions

We showed the additional value of SWI for increased certainty of diagnosing hemorrhage according to different anatomic locations in neonates. Intracranial lesions, especially intraparenchymal lesions, were frequently shown as hypersignal on T1-weighted images and hyposignal on T2-weighted images in surrounding unmyelinated white matter. Importantly, SWI showed hemorrhage in some of these patients but no hemorrhage in other patients. Thus, differentiating different neuropathologic conditions such as hemorrhage, early glial scarring or necrosis is difficult using T1- and T2-weighted images only, and the addition of SWI is shown to be valuable for differentiating hemorrhage from other conditions. Small intraventricular hemorrhage was difficult to be demonstrated on T1- and T2-weighted images, whereas SWI was very sensitive to detect this condition.
In conclusion, SWI provides additional value for increasing certainty to detect or rule out hemorrhage in neonates.

References

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