

Impairment of the medullary veins on neonatal subependymal hemorrhage using susceptibility-weighted imaging

T. Niwa¹, N. Aida¹, Y. Tachibana¹, R. Watanabe¹, T. Okabe^{1,2}, and J. Shibasaki³

¹Radiology, Kanagawa Children's Medical Center, Yokohama, Kanagawa, Japan, ²Radiology, Yokohama City University, Yokohama, Japan, ³Neonatology, Kanagawa Children's Medical Center

Introduction

Subependymal hemorrhage (SEH) occurs with a hypoxic-ischemic injury especially in preterm infants. SEH arises at the metabolically active germinal matrix as a consequence of rupture of the primitive vessel due to fluctuation in cerebral blood pressure and flow. It is known that unilateral parenchymal hemorrhagic infarction occurs in some population of infants with SEH, which is thought to be related to occlusion of the medullary veins [1, 2]. Susceptibility-weighted imaging (SWI) has been introduced as a highly sensitive magnetic resonance (MR) method for the visualization of substances with susceptibility effects such as blood, iron, calcification, and air [3]. It provides highly sensitive imaging for intracranial hemorrhage as well as venography. Despite recent increasing recognition of the clinical utilities to SWI, those for assessment of the deep veins in relation to SEH has not been well established. The purpose of this study was to assess the visualization of the branches of the deep veins in infants with SEH.

Subjects and Methods

Thirty seven neonates (gestational age, 23 – 38 weeks; corrected age at MRI, 33 – 46 weeks) with SEH, who underwent SWI, were retrospectively assessed. Infants with both SEH and periventricular leukomalacia were excluded in this study. SWI was performed with either a 1.5T or a 3T MRI unit. The sequence parameters for a 1.5T unit, TR/TE, 69/60 ms; flip angle, 12 degree; slice thickness, 1.3 mm; field of view, 150×200; matrix size, 130-150×256; GRAPPA, 2; for a 3T-MR unit, TR/TE, 38/30; flip angle, 15 degree; slice thickness, 1.2 mm; field of view, 150×200; matrix size, 224×320; GRAPPA, 2. SEH was graded as follows: Grade I, SEH with no or minimal intraventricular hemorrhage; II, SEH with extension into the ventricle; III, IVH with association with ventricular enlargement; VI, SEH with parenchymal hemorrhage. Visualization of branches of the medullary vein on SWI (i.e., thalamostriate vein, caudal veins) were rated using a four-point scale by two experienced pediatric neuroradiologists with consensus; 1, prominently visualized; 2, slightly stenotic; 3, prominently stenotic; 4, obscure or interrupted. Grade of SEH was compared to the score regarding the visualization of the medullary veins. Differences of the scores among the SEH grade were assessed using Kruskal-Wallis test followed by evaluation with the pairwise test for comparison of two proportions.

Results

The grade of SEH included I in 10, II in 13, III in 2, and IV in 12. The score of visualization of the medullary vein included score 1 in 23, score 2 in 2, score 3 in 3, and score 4 in 9. Median score in SEH-Grade I-IV were 1, 1, 2.5, and 4, respectively. There was a significant difference in score of visualization of the medullary vein among the infants according to the SEH grade ($p<0.01$). The score of the visualization of the vein in infants with SEH-Grade 4 was significantly higher than that in SEH-Grade 1 or Grade 2 ($p<0.01$).

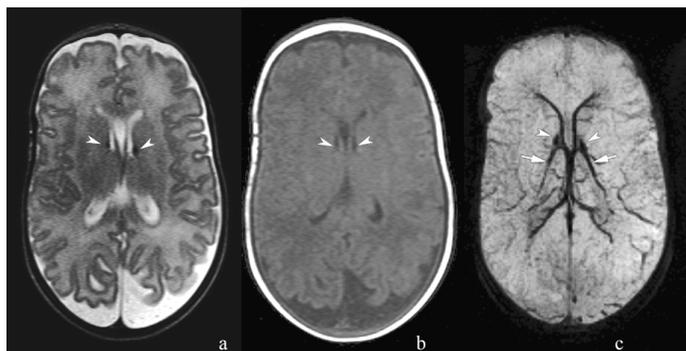


Figure 1
Subependymal hemorrhage in a preterm infant (gestational age, 26 weeks; corrected age at MRI, 37 weeks) (Grade 1).
a: T2-weighted image, b:T1-weighted image, c: SWI
Bilateral hypointense lesions are seen on images (arrowheads) at the peripheral portion of the lateral ventricle indicating germinal matrix hemorrhage. There is no intraventricular or parenchymal hemorrhage. SWI shows the bilateral thalamostriate veins without stenosis or obstruction (arrows).

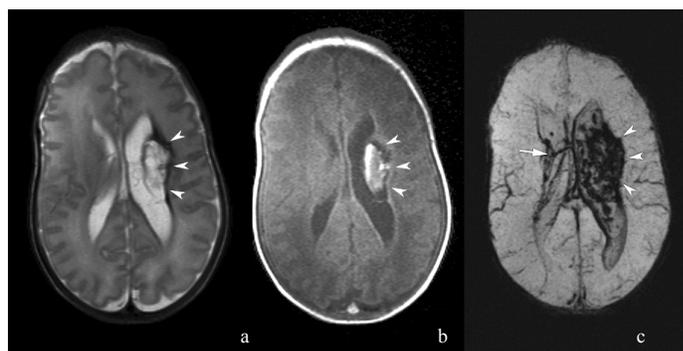


Figure 2
Subependymal hemorrhage in a preterm infant (gestational age, 24 weeks; corrected age at MRI, 37 weeks) with parenchymal hemorrhage (Grade 4).
a: T2-weighted image, b:T1-weighted image, c: SWI
Images show parenchymal hemorrhage at the peripheral portion of the left lateral ventricle (arrowheads). SWI shows the prominent right thalamostriate vein (arrow), but obscure left thalamostriate vein.

Discussion and Conclusions

We found more frequently impaired branches of the medullary veins in infants with SEH-Grade IV. On the contrary, SEH with lower grade showed less frequent relation to the impairment of the medullary veins. SEH-Grade IV had been thought to extensions of germinal matrix bleeds into the surrounding parenchyma. However they are currently thought to results from venous infarction due to occlusion of collector veins (i.e., the branches of the medullary veins) by the results of postmortem studies [2,4]. The results in this study support these previous studies. It should be noted that SWI shows these venous impairment even in vivo.

In conclusion, SEH with parenchymal hemorrhage may be accompanied with more frequent impairment of the branches of the medullary veins.

References

1. de Vries LS, Roelants-van Rijn AM, et al (2001) Unilateral parenchymal haemorrhagic infarction in the preterm infant. *Eur J Paediatr Neurol*. 5:139-49
2. Dudink J, Lequin M, et al (2008) Venous subtypes of preterm periventricular haemorrhagic infarction. *Arch Dis Child Fetal Neonatal Ed*. 93, F201-6.
3. Haacke EM, Xu Y, Cheng YC, Reichenbach JR (2004) Susceptibility weighted imaging (SWI). *Magn Reson Med* 52, 612-618.
4. Barchovich AJ. *Pediatric neuroimaging*. 4th edition. Lippincott Williams & Wilkins. 2005