Flow-sensitive black blood imaging for evaluating vascular malformations.

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Purpose

Susceptibility-weighted imaging (SWI) is sensitive to venous vasculature and can be a powerful tool for evaluating vascular malformations such as venous angiomas. For SWI, a high- resolution three-dimensional gradient echo sequence is usually used with a long TE and flow compensation (gradient moment nulling: GMN). To enhance the visibility of vascular structures, we developed a new technique with dephasing gradients (flow-sensitive black-blood: FSBB) instead of GMN. The purpose of this study was to estimate the utility of the FSBB sequence in the evaluation of vascular malformations comparing with the usual SWI sequence with GMN (flow-insensitive black blood: FIBB).

Materials and Methods

Seventeen patients (9 males and 8 females, 4 -67 years old) with a vascular malformation underwent MR examination including a FSBB and FIBB imaging. Final diagnosis included: 8 venous malformations (VM), 7 arteriovenous malformations (AVM), and 2 dural arteriovenous fistulas (dAVF). All examinations were performed on a clinical 1.5T scanner (EXCELART Vantage ZGV, Toshiba). FSBB and FIBB imaging was added to conventional imaging sequences. In the FSBB sequence, dephasing gradients were applied in the three axes, instead of second-order GMN of the FIBB sequence. Each BB imaging was performed with following parameters: TR/TE = 50/40 ms, FA = 20°, FOV = 22 cm, matrix = 256 or 320 X 256, slice thickness = 2 mm, speed-up factor = 2. Zero-fill-interpolation (ZIP) was used in all three directions. To enhance the visibility of the venous structures, the magnitude images were multiplied four times with a phase mask.

Results

All VMs were more clearly visualized on FSBB images than FIBB (Fig. 1). In two patients, a small VM was missed on FIBB images. In one patient, some portions of the draining vein could not be clearly visualized on FIBB images. This finding suggested that direction of vessels to the magnetic field influenced to their visualization on FIBB images (Fig. 2). Drainage veins of AVMs and dAVFs can be hyperintense on FIBB images probably because of their arterialization due to the arteriovenous shunt (Fig. 3). In spite of flow compensation, feeding arteries sometimes showed signal loss on FIBB images. On FSBB images, all of arteries, niduses, veins, and hemorrhagic lesions appeared as “black” structures. In five patients with AVM or dAVF, prominent venous structures other than drainage veins were noted especially on FSBB images. These veins seemed to reflect hemodynamic changes such as venous congestion, collateral circulation, and steal phenomenon associated with the AVM and dAVF (Fig. 4).

Conclusion

FSBB imaging can be a feasible tool for evaluating vascular malformations.

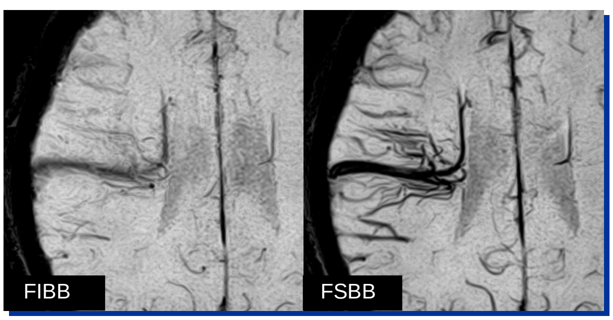

Fig. 1. Venous malformation (minIP). Detailed vascular structures are more clearly visualized on the the FSBB image.

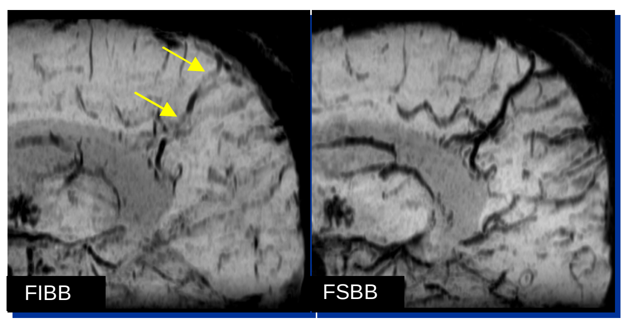

Fig. 2. Venous malformation (minIP in the sagittal plane). Some portions of the drainage vein is not clearly visualized on the FIBB image (arrows).

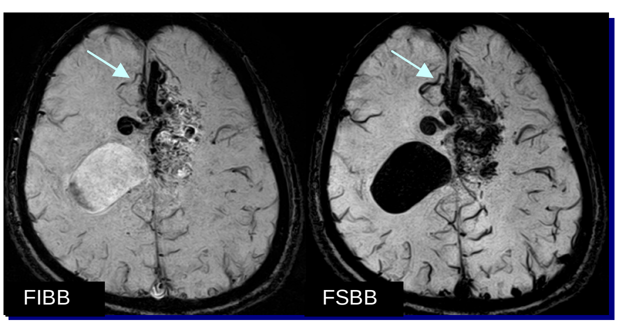

Fig. 3. AVM (minIP). The large varicous drainage vein shows hyperintenisty on FIBB image. Some of feeding areries shows hyperintensity on the FI- and FSBB image (arrows).

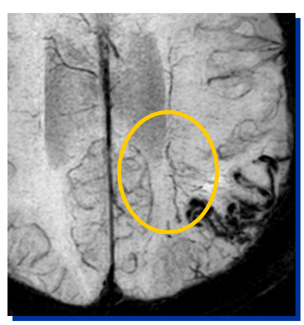

Fig. 4. AVM (FSBB, minIP). Medullary veins near the nidus of the AVM seem to be prominent comparing to the counter part (circle). This may reflect the local hypoxia due to the “steal phenomenon”.

Reference

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