Clinical Applications of Susceptibility Weighted Imaging

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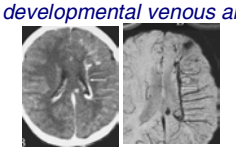
Introduction: Susceptibility weighted imaging (SWI) is a new MR imaging technique of the brain used to increase the conspicuity of the veins and other sources of susceptibility effects. SWI consists of using both magnitude and phase images from a high-resolution, three-dimensional, fully velocity compensated three-dimensional gradient echo sequence with gradient moment nulling in all three orthogonal directions [1].

Aim: To demonstrate the utility of SWI in diverse clinical situations, including the demonstration of normal and abnormal venous anatomy of the brain, intracranial hemorrhage, calcifications, architecture of vascular malformations, brain tumors, neurodegenerative diseases and sequele of infarcts and post-traumatic brain damage.

Materials and Methods: 216 patients were studied using Spin Echo (SE) T1, Turbo Spin Echo (TSE) T2, routine 2D Gradient Echo (GRE) and SWI (TR/TE/FA/TA= 48/40mS/20°/2.58 min, PAT x 2) sequences. The examinations were performed on a 1.5 T clinical scanner (Avanto- SQ engine, Siemens, Erlangen, Germany) and the images were acquired with a phased array 12 channel head coil. Post processing was applied to increase the conspicuity of the veins and other sources of susceptibility effects and projected using a minimal intensity projection (minIP). In addition phase images were also used to demonstrate susceptibility due to calcium and iron in the brain regions under evaluation.

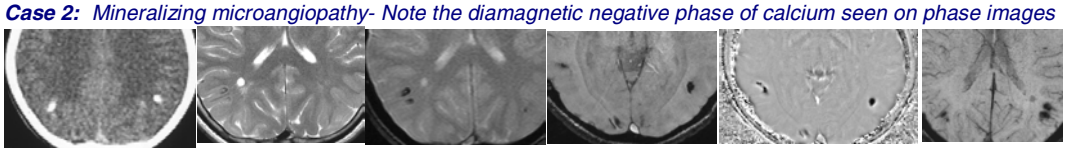
Results: The pathologies demonstrated included developmental venous anomalies, cavernous angiomas, hemorrhage, venous vascularity and calcifications in tumors, granulomas, venous displacements in mass lesions, and hemorrhage in arterial, venous infarcts and laminar cortical necrosis. The susceptibility effects and hence the conspicuity of the lesions were best demonstrated by SWI compared to conventional sequences including GRE. In addition the minIP and phase images could demonstrate intracranial iron deposition and calcification in various disorders of the brain. Areas of calcification and hemorrhage could be differentiated using phase images, using the property of diamagnetic and paramagnetic susceptibility phase differences [2]. In brain trauma, particularly diffuse axonal injury; the use of SWI dramatically changed the diagnostic confidence level.

***Case 1**: Left hemispheric large developmental venous anomaly*



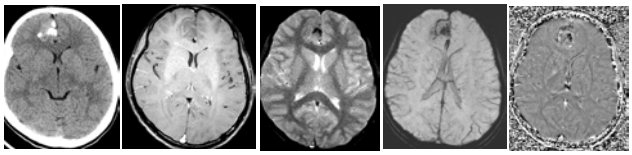
CE CT minIP SWI

***Case 2:** Mineralizing microangiopathy- Note the diamagnetic negative phase of calcium seen on phase images*



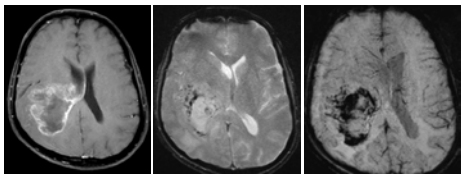
Plain CT HR T2 TSE 2D GRE SWI Magnitude SWI Phase SWI minIP

***Case 3**: Right frontal Oligodendroglioma. The tumoral calcification and the peritumoral veins could be differentiated on phase images [Bright- vein (paramagnetic), dark –calcium (diamagnetic)]*



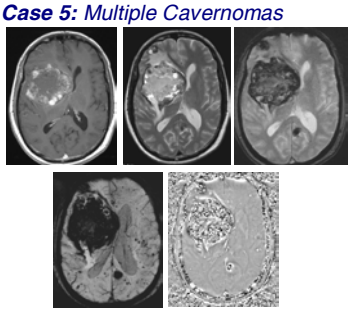
Plain CT CE T1 Fat Sat 2D GRE minIP SWI Phase SWI

***Case 4:**Glioblastoma multiformae*



CE T1 Fat Sat 2D GRE minIP SWI

***Case 5:** Multiple Cavernomas*



Conclusion: SWI proves to be a useful adjunct to routine MR sequences in demonstrating susceptibility effects due to various causes. It also helps in differentiating between causes of diamagnetic and paramagnetic susceptibility.

Reference: 1. Sehgal V, Delproposto Z, Haacke EM, et al. Clinical applications of neuroimaging with susceptibility-weighted imaging.J Magn Reso Imaging. 2005; 22:439-50.

2.Yamada N, Imakita S, Sakuma T, Takamiya M. Intracranial calcification on gradient-echo phase image: depiction of diamagneti susceptibility.Radiology. 1996;198:171-8.

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