Clinical Applications of Susceptibility Weighted Imaging

B. Thomas¹, C. Kesavadas¹, A. K. Gupta¹, T. Krishnamoorthy², N. K. Bodhey¹, and T. R. Kapilamoorthy¹

¹Department of Imaging Sciences and Interventional Radiology, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, Kerala, India

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 sequelae 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 angiomomas, 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

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

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 multiforme

Plain CT  CE T1 Fat Sat  2D GRE  minIP SWI

Case 5: Multiple Cavernomas

Plain CT  CE T1 Fat Sat  2D GRE  minIP SWI

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 causes of diamagnetic and paramagnetic susceptibility.

Reference:

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