Susceptibility-weighted imaging with the aid of dedicated software in assessment of brain tumors vascularization.

Agata Majos[1], Julia Wieczorek-Pastusiak[1], Marek Kociñski[2], Micha³ Strzelecki[2], and Ludomir Stefañczyk[1]
[1]Radiology, Medical University of Lodz, Lodz, Poland, [2]Institute of Electronics, Technical University of Lodz, Lodz, Poland

Three-dimensional, high-spatial resolution susceptibility-weighted imaging (SWI) is a novel, interesting MRI sequence, which combines filtered phase data and magnitude data images to demonstrate the susceptibility differences between adjacent tissues. The utility of SWI has been confirmed in intracranial pathologies like vascular malformations, cerebrovascular disease, hemorrhage, trauma and neurodegenerative disorders. Furthermore, SWI is promising to be a useful sequence for tumor imaging and – what is much more important, grading - fundamental information in determining therapy and survival. That is because intralesional vascularization correlate with tumor grade. So far contrast-enhanced T1 (CE T1) sequence was considered commonly of the highest value in assessing this aspect of CNS neoplasms. However, it is well known that the enhancement of the brain lesion in CE T1 depends not only on the neoangigenesis in the tumor but also on the blood-brain barrier disruption. That is why the precise evaluation of amount of vessels in CE T1 sequence can be difficult and that is why SWI sequence is so interesting enabling differentiation between these two.

Additionally, the evaluation of the quantity of vessels in SWI sequence was provided in a subjective way as a rule. MRI sequences were evaluated by individual radiologists therefore the results were dependent on their methods of interpretation. We used a dedicated, authors` computer program to objectify assessment of SWI images.

The aim of the study was to prove the usefulness of SWI in evaluation of brain tumors vascularization in comparison to CE T1 sequence in a standardized, objective way.

Materials and methods: 10 patients (8 men and 2 female; age: 41-81; average:66) with supratentorial brain tumors were included. Imaging was performed using a 12-channel phased array head coil in a 1.5 T clinical scanner (Avanto, Siemens). Each of them underwent conventional MRI examination, additionally the SWI sequence was performed with parameters: TR-49ms, TE-40ms, FOV-230, slice thick.-2mm, matrix-177x256, Flip angle-15°.

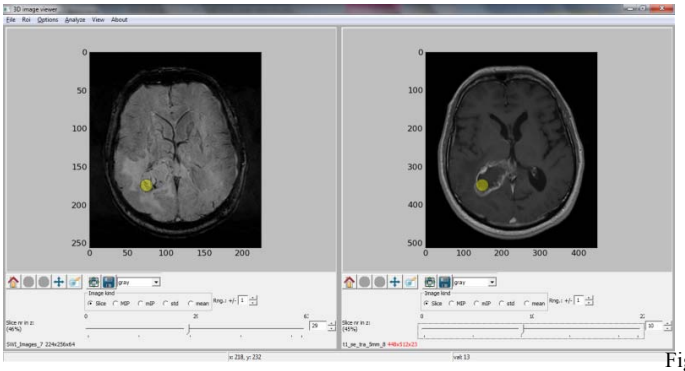

Fig.1

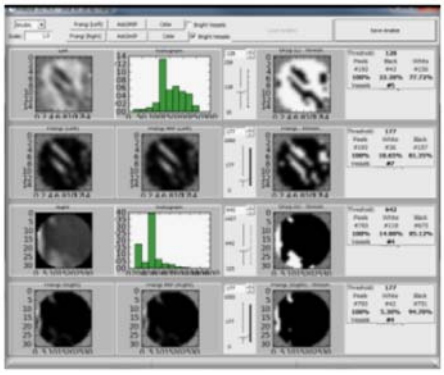

Fig.2

To assess the number of vessels in CE T1 and SWI sequences a computer application – Vessels View was written. For each patient we loaded two different data sets – CE T1 and SWI, in order to display corresponding 2D image slices. The next step was to choose a circular-shaped ROI for analysis. At least one ROI (from 1-6, 27 in total) within the lesion was selected. Fig1 Then, within the selected ROI, algorithm of image segmentation was applied with the use of vessel enhancement filter proposed by Frangi. Fig.2 The chosen part of image - with highlighted vessels and suppressed surrounding tissue, was the outcome of the filtration. To estimate the quantity of blood vessels within the ROI we applied the algorithm of global thresholding. The results of each analysis were presented as the ratio of white pixels to all pixels and as the number of elongated, connected structures complying with the number of vessels.

The results of our analysis of exemplary ROI's (because of lack of space in the abstract - 10 from 27) are presented in Tab.1 After analyzing all 27 ROI the program identified similar number of elongated structures (vessels) in both sequences. There was a predominance of SWI sequence in the amount of white pixels per ROI in comparison with CET1. This is the result of the obvious difference between vessels and surrounding tissue in SWI, which suggests better visualization of vessels in the latter.

In conclusion our results were encouraging. The program serves as the assistance for Radiologist as it exposes the vessels and facilitates to isolate them from adjacent tissues in the image. What is more, it allows comparing CE T1 and SWI images in parallel. The big advantage of SWI in the assessment of neoangiogenesis is that the disruption of brain-blood barrier is not seen there, so we can easily point out the structures which are vessels. In CE T1 the enhancement can deal with the whole lesion which can be an impediment in vessels identification. Our research has shown a deficiency in Vessels View program. Since it helps to analyze two-dimensional images there is a possibility that it can count one vessel more than once. Works on creating three-dimensional images in Vessel View improved version are ongoing to expand analysis.

1. Multiscale Vessel Enhancement Filtering. Frangi A F.et al.MICCAI'98, Lecture Notes in Computer Science, vol. 1496; 130-137
2.Susceptibility-Weighted Imaging: Technical Aspects and Clinical Applications, Part 1 Haacke E M et al., AJNR 2009; 30:19-30 3.Susceptibility-Weighted Imaging: Technical Aspects and Clinical Applications, Part 2 Mittal S et al., AJNR 2009; 30:232–52
4.Three-dimensional susceptibility-weighted imaging at 3 T using various image analysis methods in the estimation of grading intracranial gliomas; Masaaki Hori et al. Magnetic Resonance Imaging 28 (2010) 594–598

Patient/ex. ROI		I/1	II/ 1	III/ 2	IV/ 6	V/ 1	VI/ 1	VI I/3	VI II/1	IX/ 1	X/ 1
SWI	White px (%)	17, 1%	22, 8%	13, 5%	18, 7%	10, 4%	26, 4%	18, 1%	22, 8%	27, 5%	23, 8%
	Vessels (#)	4	8	8	7	2	8	10	8	7	10
CE T1	White px (%)	7,8 %	14, 1%	12, 6%	14, 9%	1,1 %	16, 7%	5,9 %	7,6 %	8,6 %	16, 3%
	Vessels (#)	7	8	6	4	2	12	8	6	10	13

Tab.1