Research Article

Susceptibility Weighted Image is A Tool for Discrimination Area of Hemorrhagic Transformation Compared with Mdct

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Abstract
Background: The advent of new magnetic resonance imaging (MRI) techniques has improved acute stroke diagnosis. Susceptibility weighted imaging (SWI) has an important role in the management of cerebro-vascular strokes. **Patients and Methods:** The study was conducted upon 50 patients clinically diagnosed with acute stroke and referred to department of radio-diagnosis, Faculty of Medicine, Minia University. Computed tomography (CT) was done at first then magnetic resonance imaging was performed on a 1.5T Philips MR system using conventional MRI sequences as fluid attenuated inversion recovery (FLAIR), T2-weighted, T1-weighted and advanced sequences as susceptibility-weighted imaging (SWI) with the parameters including slice thickness, voxel size, field of view (FOV) and matrix. They were done after the approval of ethical committee of our institution. Informed written consents were taken from the patients or their relatives. **Results:** In our study, we found that 50 patients presented with acute non hemorrhagic infarction even on SWI and 7 patients presented with hemorrhagic infarction noted in SWI. No patients show any hemorrhagic infarction detected in CT. We found that detection rate of hemorrhage in SWI sequence was (100%). **Conclusion:** From this study we concluded that new imaging SWI MRI modality is a valuable MRI sequence in imaging hemorrhagic transformation in ischemic stroke.
Key Words: MRI, SWI, hemorrhage, stroke, infarction.

Introduction
Stroke or cerebrovascular accident (CVA) is a clinical term which represent a sudden neurological insult persisting for more than 24 hours as a sequel of an alteration of normal blood supply to the brain. Stroke is the third leading cause of mortality worldwide with significant morbidity rate among survivors. In hemorrhagic stroke, bleeding occurs directly into the brain parenchyma.

The usual mechanism is thought to be leakage from small intra-cerebral arteries damaged by chronic hypertension. Imaging of stroke is used to differentiate ischemic from hemorrhagic stroke, arterial from venous infarction and to distinguish anterior and posterior circulation strokes. (1) Non-contrast head CT (NCCT) is the first-line diagnostic test for emergency evaluation of acute stroke due to its speed of imaging, widespread availability and low cost. In CT small infarcts are less likely to be visible and detect parenchymal hemorrhage with near 100% accuracy only within 5–7 days of stroke. From this point of view, magnetic resonance imaging (MRI) is increasingly being used in the diagnosis and management of acute ischemic stroke and is sensitive and relatively specific in detecting changes that occur after such strokes. Magnetic resonance can detect acute hemorrhage within ischemic area through the first six hours.(2)

Routine MR sequences remain specific for hemorrhage in 90% of patients.(3) In the remaining 10% detection of hemorrhage may be difficult as low signal caused by haemosiderin not visible on spin echo T2 MR and other sequences vary in their sensitivity to the presence of haemosiderin. So it is imperative to use new imaging technique as susceptibility weighted imaging (SWI). It is a magnetic resonance (MR) technique that is exquisitely sensitive to paramagnetic substances such as deoxygenated blood, blood products, iron and calcium. Susceptibility weighted imaging (SWI) used to asses ischemic area in patients with acute ischemic infraction based on elevation of deoxy-hemoglobin to oxy-hemoglobin ratio in venous system of the ischemic brain tissue with hypo-perfusion which contributes to the magnetic susceptibility difference between veins and the surrounding ischemic brain tissue.[4,5] Deoxy-hemoglobin within the veins lead to visualization of prominent vein (which appear hypointense) over the affected cerebral hemisphere on susceptibility-weighted imaging (SWI) called prominent vein sign.

This property accounts for the blood oxygen level dependent (BOLD) effect.[6] Susceptibility-weighted imaging can detect spontaneous hemorrhagic transformation of ischemic stroke earlier than CT scans as it is more sensitive in detecting minute amount of hemorrhage within infarction than CT.[7,8] However, the ability of SWI to detect recurrent hemorrhage has not been assessed. It detects microbleed which may be a marker for patients at risk for intra-cerebral hemorrhage. Early detection of bleeding within ischemic area is very important as hemorrhage is a contraindication to the use of anticoagulant and thrombolytic therapy in the acute stroke setting. Also SWI used to assess intravascular clots as it detects thrombus within intracranial artery which appear dilated and hypointense in comparison with the other side giving what is called blooming artifact. SWI sequences also have the potential to assess tissue viability.[9,10] Assessment of ischemic penumbra is essential for predicting evolution or deterioration in patients with acute ischemic infraction.[10]

Aim of the work:

The aim of this study is to assess the role of susceptibility-weighted imaging in assessment of hemorrhagic transformation in patients with acute ischemic infraction.

Patients and method

Study design and population

In a prospective study 30 patients with clinically diagnosed to have acute stroke were included diagnosed in neuropsychiatry department and they were referred to department of radio-diagnosis, Faculty of Medicine, Minia University. The study was done between October 2018 to September 2019. The examination was done after the approval of ethical committee of our institution. Informed written consents were taken from the patients or their relatives

Inclusion and exclusion criteria

Inclusion criteria:

- All patients included in this study were diagnosed clinically having acute stroke.
- Age older than 18 years.
- Stroke symptoms lasting >1 hour.
- National Institutes of Health Stroke Scale (NIHSS) score is more than 4.

Exclusion criteria: General contraindications to MRI as the presence of any paramagnetic substances such as pacemakers, metallic clips or claustrophobic patients were excluded from the study. Patients with an NIHSS score less than or equal to 4 were excluded.

Methods

CT scanning

CT was performed with a CT HiSpeed 16 slice scanner (GE Medical Systems, Milwaukee, WI) in the hospital emergency department using the non helical scanning technique: 120 KV, 300 mA, 1-second scanning time, and 5 mm section thickness.

MRI technique

MR imaging was performed using 1.5 Tesla MR Scanner (Ingenia, Philips Healthcare, Netherlands). All patients were imaged in the supine position using standard quadrate head coil. The MRI examination was conducted on the brain including the following MRI sequences; Axial T1 images utilizing the following parameters: repetition time (TR) of 800 msec/ echo time (TE) of 30 msec, slice thickness of 5 mm, (NSA) 3, matrix 512x 512, gap 1–2 mm, flip angle=90º and FOV = 230mm. Axial T2 weighted images utilizing the following parameters:, repetition time (TR) of 4800 msec/ echo time (TE) of 110 msec, slice thickness of 5mm, number of signal averages (NSA)=3, matrix 512x 512, gap 1–2mm, flip angle=90º and field of view (FOV)= 230mm. Axial FLAIR images utilizing the following parameters: repetition time (TR) of 6000 msec/ echo time (TE) of 140msec, slice thickness of 5mm, (NSA) 3, matrix 512x 512, gap 1–2mm, flip angle=90º and FOV = 230mm. Axial SWI images utilizing the following parameters: repetition time (TR) of 43 msec/echo time (TE) of 25msec, slice thickness of 3mm, matrix 300x300, gap 1–2mm, flip angle=20º and FOV = 230mm.

Data processing and image interpretation:
The images were transformed to Philips 881030 Intelli-Space IX/LX Workstation. They were evaluated as following:

Image interpretation:
All patients were imaged by CT and evaluated for presence of hemorrhage within infarct areas and evidence of early ischemic changes (EIC) (using stroke window width of 30 HU and center level of 35 HU) which was defined by the presence of one or more of the following findings: sulcal effacement, hyperdense MCA/ basilar artery sign, basal ganglia/ subcortical hypodensity and loss of gray-white differentiation. Then patients had MRI using conventional sequences to evaluate site, size and extension of infarct area as well as signal intensity at different pulse sequences. Presence or absence of infarction using SWI and other sequences as well as type of hemorrhage either macro-hemorrhage (more than 50% of infarct area) or pitechial hemorrhage (less than 50% of infarct area) were assessed. Detection of dark vessel and prominent cortical veins in vicinity of infarct area was also done using MRIcro software to assess venous structures in 5 consecutive sections around the level of the lateral ventricles from just above the level of basal ganglia to the highest section because these sections include most of the cerebral vein. Bilateral venous voxel counts were computed and the asymmetry index (ratio of voxel numbers of cerebral veins between the ipsilateral and contralateral side) was calculated. Each infarct area in each patient appears in CT was correlated with its similar on SWI.

Statistical analysis
Statistical analysis was performed using the SPSS software for Windows v. 20 (SPSS Inc., Chicago, IL). Tests of significance (Repeated measures ANOVA, Cochran's Q tests, Kappa statistics and ROC Curve analysis). P-values less than 0.05 (5%) was considered to be statistically significant. Mean, standard deviation (± SD) and range for parametric numerical data, while median and inter-quartile range (IQR) for non-parametric numerical data. Frequency and percentage of non-numerical data.

Results
Our study included 50 patients with acute stroke diagnosed in our neurological department. The mean age of all patients was (60) years and as regarding gender of the patients (70%) of patients were males and (30%) were females. 43 patients had no acute hemorrhage even on SWI and 7 patients had hemorrhagic infarction. 2 of those patients with hemorrhagic infarction show iso desne area in MDCT difficult to assess is it hemorrhage or normal brain tissue and 5 patients of those patients with hemorrhagic transformation detected in SWI and not in CT. We found that detection rate of hemorrhage in SWI sequence was (100%). Comparative studies between CT and SWI sequences revealed significant increase in sensitivity and specificity of detection of hemorrhage in SWI sequence with highly significant statistical difference ($p < 0.001$) as in (table I). In SWI as regarding detection of different signs of acute ischemic strokes we found that of hemorrhage was (88%), detection rate of prominent cortical veins in vicinity of infarct was (62%) and detection rate of dark vessel sign was 6%. Comparative studies between different sign in SWI was done revealed that SWI had significant increase in sensitivity and specificity of detection of hemorrhagic transformation over detection of other signs with highly significant statistical difference ($p < 0.0001$) as in table II.

Table I: detection of hemorrhagic transformation in ischemic stroke in CT in comparison to SWI using Roc-curve analysis:

	AUC	P value	SE
Hemorrhagic transformation in SWI	0.987	<0.0001	0
Hemorrhagic transformation in CT	0.497	0.015	0.032

SE= Standard Error, AUC= Area under curve, ROC =Receiver operating characteristic.

Table II: Comparison between different signs of ischemic stroke in SWI in 50 patients with ischemic stroke:

Variable	Detection rate of dark vessel sign	Detection rate of prominent cortical vein	Detection rate of hemorrhage	Cochran's Q test
				P value
SWI	(66%) ^^	(62)^^	(100%) ^^	= 0.097 ⋕

^^ % per total of 15 patients, ⋕ Cochran's Q test.

Figure 1: Axial CT image of patient show right sided subacute infarction with small iso dense area ? for hemorrhage ? normal parenchyma.

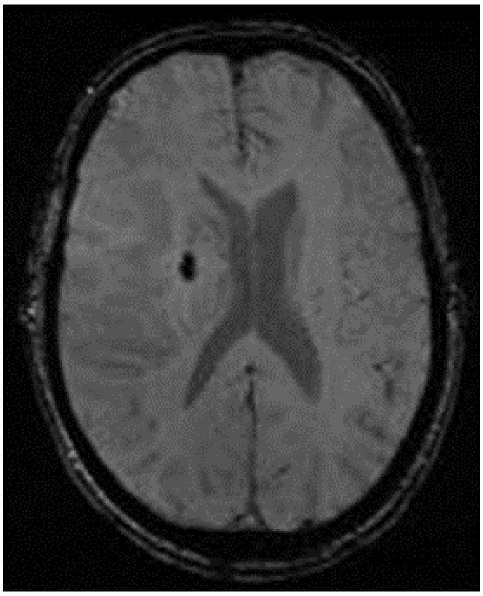

Figure 2: Axial SWI shows blooming signal seen at right parietal region denote hemorrhage .

Discussion

SWI is as an important sequence that detect critical information as regarding hemorrhagic transformation and intravascular clot of ischemic stoke. It has demonstrated advantages over conventional MRI sequences and CT imaging in detection of hemorrhagic events in the vicinity of infarction due to its exquisite sensitivity to paramagnetic substances such as deoxyhemoglobin. SWI venography allows clear visualization of cerebral veins. Shortly after arterial occlusion in patients with acute stroke, there is an increase in deoxyhemoglobin and a decrease in oxyhemoglobin within cerebral veins leads to a signal drop along the course of cerebral veins on SWI venography. SWI venography may thus provide the oxygen metabolic information about ischemic brain tissue by the noninvasive estimation of blood oxygen level. .[11] The acknowledgment of this lead to a revolution in detection of hemorrhagic transformation in ischemic stroke and increased interest in SWI. Our study aims to assess presence of hemorrhage in patients with ischemic stroke using different MRI sequences including SWI and CT imaging. Most of our patients were males (70%).

We are in agreement with several authors as Deepti Naik and Sanjaya Viswamitra Studies who reported that SWI was an important sequence in detection of hemorrhagic transformation in infarct area over CT and other MRI sequences. Chronic hemorrhages in a patient with stroke may reflect the vulnerability of the vascular system and has been suggested as a predictor for future bleed particularly in patients undergoing thrombolytic therapy. We agree with Haacke EM and Tang J et. al. study who stated that SWI can demonstrate venous changes at an infarct which appear as multiple prominent hypointense veins in the vicinity of infarct.

Conclusion

Finally, in our study we agree with the findings reported by the other studies regarding the greet value of SWI in assessment of ischemic stroke. SWI has the ability to identify several parameters such as hemorrhage which may be of prognostic value in making therapeutic decisions. Based on our study, future impleme-ntation of adding the SWI sequence beside the conventional MR sequences as a routine modality in patients with ischemic stroke is important.

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Conflict of Interest:- Nil.

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