Original article

Added Value of Diffusion Weighted Magnetic Resonance Imaging MRI in Intracranial Hemorrhage

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Abstract

Objectives: Intracranial hemorrhage is common and is caused by diverse pathology, including trauma, hypertension, and cerebral amyloid angiopathy, hemorrhagic conversion of ischemic infarction, cerebral aneurysms, cerebral arteriovenous malformations, dural arteriovenous fistula, vasculitis, and venous sinus thrombosis, among other causes. Neuroimaging is essential for the treating physician to identify the cause of hemorrhage and to understand the location and severity of hemorrhage, the risk of impending cerebral injury, and to guide often emergent patient treatment. Aim of study: is to evaluate the added value of diffusion weighted MRI in intracranial hemorrhage. **Subjects and methods**: this a prospective case series study. The Study was conducted on selected group of patients with intracranial hemorrhage, or clinical suspicion of intracranial hemorrhage. **Results:** The study showed that we found 8 cases of hyper acute blood, all are detected with DWL. 8 cases of acute blood, two cases are missed with DWL, 11 cases of early subacute blood, all are detected with DWL. 53 cases of late subacute blood, four cases are missed with DWL, 2 cases of chronic blood. **Conclusion:** DWI demonstrated the characteristic MR features of intra-cerebral hematoma at various stages. A better understanding of the DWI findings of intra-cerebral hematoma can be helpful for the differentiation of intra-cerebral hematoma from acute infarction and for the further characterization of intracranial hemorrhagic lesions.

Key words: Intracranial hemorrhage, Diffusion weighted imaging, Magnetic resonance imaging.

Introduction:

Intracranial hemorrhage (ICH) is a significant medical event that accounts for up to 15% of strokes. The incidence of ICH is approximately 25 per 100,000 person-years, and it has a mortality of 40% within one month of presentation [1]. Intracranial hemorrhage is common and is caused by diverse pathology, including trauma, hypertension, and cerebral amyloid angiopathy, hemorrhagic conversion of ischemic infarction, cerebral aneurysms, cerebral arteriovenous malformations, dural arteriovenous fistula, vasculitis, and venous sinus thrombosis, among other causes. Neuroimaging is essential for the treating physician to identify the cause of hemorrhage and to understand the location and severity of hemorrhage, the risk of impending cerebral injury, and to guide often emergent patient treatment [2].

Trauma is the most common cause of ICH, and CT of the head is the initial workup performed to evaluate the extent of acute traumatic brain injury [3]. MRI is increasingly being performed in the emergency department for the evaluation of traumatic brain injury, and MRI has been shown to be more sensitive than CT in the detection of small foci of intracranial hemorrhage or axonal injury [4]. Trauma may result in ICH through direct or indirect injury of arteries and veins located deep to the skull, and these injuries may result in ICH overlying the brain parenchyma or within the brain parenchyma. The most commonly encountered types of traumatic ICH include SAH, epidural hematoma, subdural hematoma and cerebral micro hemorrhage [5].

Aim of study

The aim of the work is to evaluate the added value of diffusion weighted MRI in intracranial hemorrhage.

Subjects and methods

This is a prospective case series study.

The study was carried on 70 patients who were referred to Radiology Department of Benha University from March 2019 to March 2020.

The approval of ethical committee at Benha university was granted before begin of work.

All of patients were subjected to:

- Full history taking.
- Full clinical examination.

- MRI study

MR examination was done for all patients using Magnetom symphony, syngo, 1.5 T machine. The conventional MR imaging protocol included (a) axial T1-weighted spin-echo (467/9 [repetition time (TR) msec/echo time (TE) msec]), (b) axial T2-weighted fast spin-echo (3417/102 [effective echo time]), and (c) axial FLAIR (10000/400/2200 [inversion time]). The parameters of conventional MR imaging were a 256 192 matrix, a 23-cm field of view, and a 5 mm/2 mm slice thickness/intersection gap. Singleshot, spin-echo, echo-planar DWI sequences were obtained by applying diffusion gradients in three orthogonal directions at each slice, with two diffusion weightings (b value = 0 and 900 or 1000 s/mm2). Isotropic DWI was generated on-line by averaging three orthogonal-axis images. The DWI examination acquired 20 slices with parameters of 6500/96.8 (TR/TE), a 128 128 matrix, a 28-cm field of view, and 5-mm slice thickness with a 2-mm intersection gap. Gradient-echo imaging (TR/TE = 450/20). The following parameters were assessed: Diffusion weighted imaging was analyzed for Type of hemorrhage; parenchymal, intraventricular, subarachnoid, subdural, and epidural. Location of the hemorrhage; cortical, subcortical or basal ganglia. Age of the hemorrhage. According to the time interval between symptom onset and initial MRI, four stages were categorized: hyperacute, acute, early subacute and late subacute.

Statistical methods

Analysis of data was done using Statistical Program for Social Science version 20 (SPSS Inc., Chicago, IL, USA). Quantitative variables were described in the form of mean and standard deviation. Qualitative variables were described as number and percent.

Results

This study was conducted on thirty patients who were referred to the Radiology Department of Benha University Hospital. The study will be carried on 70 patients. All of patients were subjected to full history taking, full clinical examination and MRI study. results we found 8 cases of hyperacute blood, all are detected with DWL. Table (1,2) figure (1)

8 cases of acute blood, two cases are missed with DWL, 11 cases of early subacute blood, all are detected with DWL. 53 cases of late subacute blood, four cases are missed with DWL, %. 2 cases of chronic blood, 1

missed with DWL. On other hand we found 41 cases of intracerebral location, 1 missed by DWI, 28 cases of subdural location, 1 missed by DWI, 7 cases of intracerebellar location, 1 missed by DWI, 3 cases of intraventricular location, all are detected by DWI %, 2 cases of intracerebral location, all are missed by DWI, 1 cases of cerebellar subdural location, all are detected by DWI. Table (3,4) figure (2)

Table (1): Agreement (sensitivity, specificity and accuracy) for type of hemorrhage with DWI

type	DWI Missed		DWI Detected Restricted		DWI Detected Other		MC	P	Sensitivity	Specificity	PPV	NPV	Accuracy
	No	**%**	**No.**	**%**	**No.**	**%**							
Intracerebral 41	3	7.3	29	70.7	9	22.0			92.7%	100%	100%	93.2%	96.3%
Subdural 28	1	3.6	18	64.3	9	32.1			96.4%	100%	100%	98.2%	98.8%
Intracerebellar 7	1	14.2	3	42.9	3	42.9			85.7%	100%	100%	98.7%	98.8%
Intraventricular 3	0	0.0	2	66.7	1	33.3	**25.511**	0.015*	100%	100%	100%	100%	100%
Subarachnoid 2	2	100.0	0	0.0	0	0.0			0.0%	100%	100%	97.6%	97.6%
Cerebellar subdural 1	0	0.0	1	100.0	0	0.0			100%	100%	100%	100%	100%

Table (2): Agreement (sensitivity, specificity and accuracy) for stage of hemorrhage with DWI

Stage	DWI Missed No	%	Detected Restricted No.	%	Other No.	%	MC	P	Sensitivity	Specificity	PPV	NPV	Accuracy
Hyper acute													
8	0	0.0	6	75.0	2	25.0			100%	100%	100%	100%	100%
Acute													
8	2	25.0	1	12.5	5	62.5			75.0%	100%	100%	97.4%	97.6%
Early subacute													
11	0	0.0	1	9.1	10	90.9	**50.045**	<0.001*	100%	100%	100%	100%	100%
Late subacute													
53	4	7.5	45	84.9	4	7.5			92.5%	100%	100%	87.8%	95.1%
Chronic													
2	1	50.0	0	0.0	1	50.0			50%	100%	100%	98.8%	98.8%

Table 3: Distribution of the studied cases according to detected or not detected with DWI

Haemorrhage (n = 82)	No.	%
Detected	75	91
Missed	7	8.5

Table (4): Distribution of the studied cases according to DWI

DWI	No.	%
(n = 82)		
A:Hyperintense	53	64.6
B:Hypointense	22	26.8
C:Isointense	0	0
D ; mixed	0	0
Missed casses	7	8.5

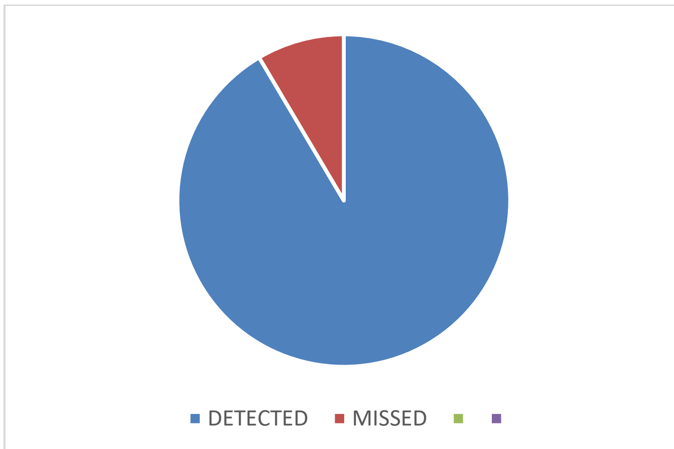

Fig (1): Distribution of the studied cases according to detected or missed with DWI

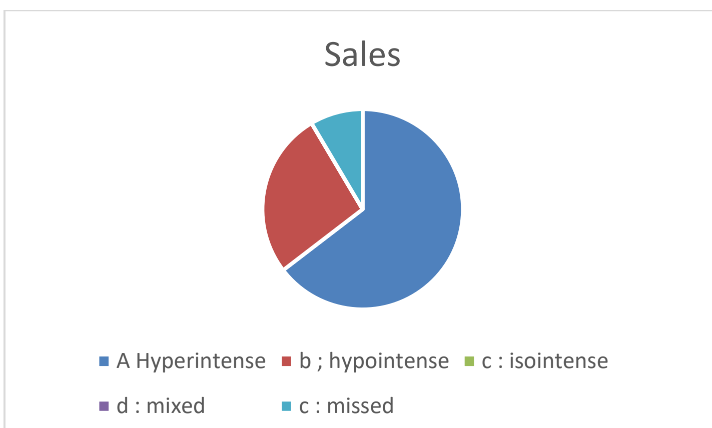

Fig (2): Distribution of the studied cases according to DWI

Discussion

The usual pattern of magnetic resonance (MR) appearances corresponding to the different stages of intracerebral hemorrhage (ICH) is well known. The generalized model for the appearance of ICH on MR images attributes the various signal intensity patterns of evolving ICH to the oxygenation state of hemoglobin and the integrity of the red blood cells. Despite the frequent use of conventional MR imaging to evaluate the appearance and underlying biophysical basis of evolving ICH over the past few years, diffusion-weighted MR imaging (DWI) has only recently been recognized as a valuable investigative resource [6]. DWI is a relatively new technique which, by using additional strong diffusion-sensitizing gradients, is extremely sensitive to changes in the microscopic motion of water protons. It has proved valuable in the study of the natural history of ischemic stroke and is now a promising technique for the early detection of cerebral infarction in routine clinical practice. Although several recent studies using DWI have mainly focused on hyperacute and acute hemorrhages, its clinical reliability for differentiation between hemorrhage and infarction in hyperacute stroke has not been established. Furthermore, the various DWI features of ICH and the underlying biophysical mechanisms have not been clearly addressed [7] . In this study we found that there were 42(60%) male, 28(40%) female, the mean age 47.62 (± 19.75 SD) with range (0.17 – 80.0). The study will be carried on 70 patient. All of patients were subjected to full history taking, full clinical examination and MRI study. We found 8 cases of hyperacute blood, all are detected with DWL . 8 cases of acute blood , two cases are missed with DWL , 11 cases of early subacute blood , all are detected with DWL. Fifty three cases of late subacute blood , four cases are missed with DWL , 0.2% cases of chronic blood , 1 missed with DWL . On other hand we found 41 cases of intracerebral location , 1 missed by DWI , 28 cases of subdural location , 1 missed by DWI , 7 cases of intracerebellar location , 1 missed by DWI , 3 cases of intraventricular location , all are detected by DWI % , 2 cases of intracerebral location , all are missed by DWI, 1 cases of cerebellar subdural location , all are detected by DWI .

Conclusion:

DWI demonstrated the characteristic MR features of intra-cerebral hematoma at various stages. We suggest that the biophysical mechanisms behind the signal changes observed at DWI are multifactorial. A better understanding of the DWI findings of intra-cerebral hematoma can be helpful for the differentiation of intra-cerebral hematoma from acute infarction and for the further characterization of intracranial hemorrhagic lesions.

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