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Radiodiagnosis

CORRELATION BETWEEN MRI AND MRA IN CASES OF CEREBRAL ISCHEMIC STROKE.

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ABSTRACT MRI is superior to CT when therapeutic interventions are considered1.

MR imaging in stroke is targeted towards assessment of– Parenchyma , extra cranial and intracranial circulation , assess CBV, CBF and MTT, and Penumbra .

Diffusion-weighted MR imaging is more sensitive for detection of hyper acute ischemia. Diffusion-perfusion mismatch indicates penumbra. Gradient echo MR sequences aid in detecting hemorrhages.

MR angiography enables to assess the status of the neck and intracranial vessels. MR angiography is a Clinically important non-invasive method for the evaluation of vascular structures of neck and intracranial vessels.

AIMS & OBJECTIVES: Role of MRI in the detection of cerebral ischemic stroke.

To analyze the socio-demographic profile and risk factors in patients with cerebral ischemic stroke.

To determine the location and the territory of the involved blood vessels.

Role of non-contrast MR angiography in the detection of salvageable tissue (penumbra) The incidence of negative cases (stroke mimics).

SELECTION OF PATIENTS:

Study design: Observational Cross-Sectional Study.

Study duration: Study was carried over a period of 2 years from February 2015 to February 2017.

Sample size: A total of 300 patients referred to the Department of Radio-Diagnosis ,ASRAM MEDICAL COLLEGE , with clinical suspicion of cerebral ischemic stroke are included in the study based on the inclusion criteria.

All MRI scans were performed on a 1.5T Seimens Magnetom.

INCLUSION CRITERIA: All patients clinically suspected of cerebral ischemic stroke Cases of all age groups irrespective of sex.

EXCLUSION CRITERIA: Patients with history of the metallic implant, foreign body, pacemaker, aneurysm clip, recently implanted prosthetic valve. Patients too unstable to undergo MRI scan who are on ventilator support. Patients with history of claustrophobia.

KEYWORDS : DWI: Diffusion Weighted Imaging, MRA: Magnetic Resonance Angiography PWI: Perfusion Weighted Imaging

INTRODUCTION

Stroke is the major cause of disability worldwide ,defined as an acute central nervous system injury due to occlusion of the lumen by embolus or thrombus, rupture of a vessel, an altered permeability of the vessel wall or increased viscosity or other change in the quality of blood flowing through the cerebral vessels CT and MR imaging (MRI) are widely used for imaging of the cerebral parenchyma and its anatomic structure in acute stroke ,and helps to exclude hemorrhage and other causes which may closely mimic stroke, such as infection and neoplasm.

CT SCAN is the fundamental investigation in acute stroke. It helps to detect the presence of infarction and exclude hemorrhage, tumor and allows assessment of both intracranial and extracranial circulation.

MRI is superior to CT when therapeutic interventions are considered.

Conventional MR Imaging reveals acute infarcts with 80% sensitivity on day 1 as compared to 60% on CT scan.

MR Diffusion Imaging is uniquely sensitive to the earliest changes which can be detected as early as 15 minutes after vessel occlusion.

Advantages of MRI over CT are, it is sensitive for the detection of edema, provides multiplanar views and lacks beam hardening artifacts. Also with MRI, there is no ionizing radiation associated, non-contrast MR Angiogram is possible and the gadolinium-based contrast media has a minimal risk for toxic effects Correlation of the MRI findings with the clinical features is very helpful in arriving the diagnosis and look for involvement of the specific sites

MR imaging in stroke is targeted towards assessment of the four P's – Parenchyma (assess early signs of acute stroke, rule out hemorrhage), Pipes (assess extracranial and intracranial circulation for evidence of IV thrombus), Perfusion (assess CBV, CBF and MTT), and Penumbra (assess tissue at risk of dying if ischemia continues without recanalization of IV thrombus) as described by Rowley[8]. This approach enables the detection of intracranial hemorrhage, differentiation of infarcted tissue from salvageable tissue. identification of intravascular thrombi, selection of the appropriate therapy and priediction of clinical outcome.

MR angiography enables to assess the status of the neck and intracranial vessels.

MR spectroscopy provides information regarding the abundance of metabolites[2].

MRI is efficacious for an extensive evaluation of acute stroke. To improve patient selection, it is a quick diagnostic tool that enables reliable diagnosis of hemorrhage and ischemia, vessel status and tissue at risk at an early stage, which may be beneficial.

In this study, we explain the significance and feasibility of multiplanar MRI for the initial evaluation of stroke and also to rule out the presence of hemorrhage or others such as stroke mimics. We will also briefly compare the sensitivity of DWI in acute infarcts and the use of DWI –MRA mismatch criteria as a surrogate for DWI- PWI mismatch for detection of penumbra thus providing a guide for stroke management.

MAGNETIC RESONANCE ANGIOGRAPHY :

Clinically important non-invasive method for the evaluation of vascular structures.[3]The 2 basic techniques used are time-of-flight (TOF) and phase-contrast (PC) magnetic resonance angiography.

Time-of-flight MRA :

3D TOF MRA depicts normal and occluded vessel wall but is less useful for slow flow lesions, because of spin saturation may cause overestimation of stenosis.[4] 2D TOF MRA correlates well with contrast arteriography in evaluating cervical carotid bifurcation disease.[5]

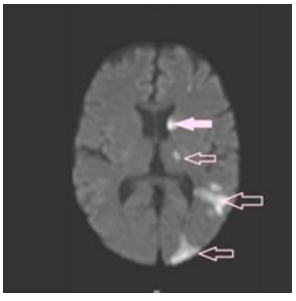
A modified TOF technique that used multiple overlapping thin slab

acquisition (MOTSA) combines the advantages of both 2D and 3D TOF techniques and severe stenosis with the slow flow are well depicted with this technique.

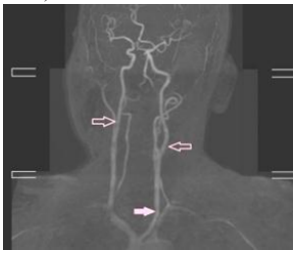
Phase-contrast MRA:
Is helpful in differentiating abnormally slow flow from normal flow.[6] PC MRA can also be used to provide directional information and quantify flow velocities. A relative disadvantage of 2D PC MRA compared to techniques is increased signal loss from intravoxel phase dispersion resulting from complex or turbulent flow in tortuous arteries.

MRA enables the non-invasive evaluation of vascular patency. MRA also defines the anatomy of the Circle of Willis and the presence or absence of posterior and anterior communicating arteries which can provide collateral blood supply during an acute ischemic event. Imaging of the carotid arteries in the neck can be useful to identify treatable carotid stenoses that may contribute to chronic ischemia or to future acute ischemic episodes. MRA can also be useful in planning endovascular treatments when appropriate.

Both TOF and PC angiograms can be performed using 2D or 3D techniques. 2D studies have higher sensitivity to flow detections and 3D MRA provides better spatial resolution and reconstructed images are seen better with 3D studies.



DWI – Areas of restricted diffusion (hyperintensities) noted in the Lt. thalamus as well as Lt. caudate nucleus and Lt. Occipito-parietal lobes (was negative in T2WI).



MRA – Bilateral proximal internal carotid artery shows 50% narrowing (open arrow) Proximal Lt . common carotid artery shows 70% narrowing (solid arrow).

The concept of Ischemic Penumbra:
Cerebrovascular tissue undergoing ischemia has two layers:
(a) outer layer of less severe ischemia (penumbra), supplied by collaterals, and contain cells which can be retrieved by timely therapeutic intervention;
(b) inner core of severe ischemia with blood flow below 10–25%, displaying necrosis of both neuronal as well as supporting glial elements.

Deleterious processes propagating from the core to the penumbra can induce additional mechanisms of damage, contributing to the evolution of the ischemic lesion.Such mechanisms include oxidative stress, nitric oxide overproduction, release of inflammatory cytokines (eg, tumor necrosis factor and interleukin-6), expression of adhesion molecules (eg, intercellular molecule adhesion-1 and vascular cell adhesion molecule), and production of matrix metalloproteinases B. Neurons in the penumbra are mostly dysfunctional, but may recover if reperfused in time. This forms the basis of current protocols which favor early pharmacological intervention for re-canalization of the occluded vessel.

The primary goal of imaging patients with acute stroke symptoms is to distinguish between hemorrhagic and ischemic stroke. In ischemic stroke patients, secondary goals are the identification of the location and extent of the intravascular clot as well as the presence and extent of "ischemic core" (irreversibly damaged tissue) and "penumbra" (hypoperfused tissue at risk for infarction). In addition, early identification of the stroke etiology or mechanism (eg, carotid atherosclerotic disease, vascular dissection, or other treatable structural causes) is critical to treatment decisions and long-term management.

Conventional MR Imaging reveals acute infarcts with 80% sensitivity on day 1 as compared to 60% on CT scan. MR detection of posterior fossa strokes and to identify lacunar infarcts and brainstem infarcts with high sensitivity.

MR Diffusion Imaging is uniquely sensitive to the earliest changes which can be detected as early as 15 minutes after vessel occlusion.

MR Perfusion Imaging is another MR technique that is complementary to DWI and which provides information on the hemodynamic status of tissue and can detect impaired perfusion in both ischemic core and penumbra.

Combined DWI and PWI can provide detection of brain parenchyma at risk and may be salvageable by thrombolytic therapy.
MR Angiography can be used to display major cerebral vascular anatomic details in stroke patients without the need for an injection of contrast materials it can provide functional information about flow dynamics in the circle of willis.

IMAGING CEREBRAL PARENCHYMA CONVENTIONAL MRI TECHNIQUES:
MR FINDINGS :
Immediate
- The absence of normal "flow void"
- Intravascular contrast enhancement
- Low apparent diffusion coefficient (ADC)
- Perfusion alterations

< 12 Hours
- Anatomic alterations on Tl Wl
- Sulcal effacement
- Gyral edema
- Loss of grey-white interfaces

12-24 hrs
- Hyperintensity on T2WI develops
- Meningeal enhancement adjacent to the infarct
- Mass effect

1-3 days
- IV meningeal enhancement begin decreasing early parenchymal contrast enhancement
- signal abnormalities striking on T1WI, T2WI
- The hemorrhagic transformation may become evident

4-7 days
- Striking parenchymal contrast enhancement
- Hemorrhage apparent in 25%
- Mass effect, edema begin diminishing
- IV meningeal enhancement disappears.

1-8 weeks
- Contrast enhancement often persists
- Mass effect resolves
- The decrease in abnormal signal on T2 WI sometimes noted (fogging effect)
- Hemorrhagic changes evolve, become chronic

Months to years
- Encephalomalacic changes,
- Volume loss in affected vascular distribution
- Hemorrhagic residua (hemosiderin/ferritin)

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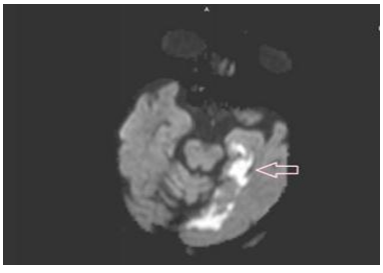
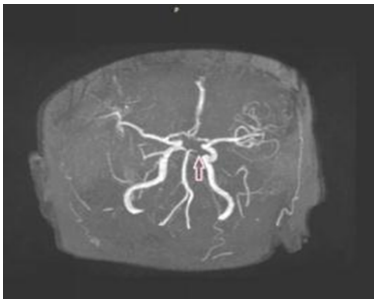
Acute infarct in the left occipital lobe with occluded Left PCA



DWI – restricted diffusion noted in left hippocampus & left occipital lobe.



MRA occluded left PCA noted

DISCUSSION

This study was directed to evaluate the role of MRI in patients presenting with cerebral ischemic stroke and also to differentiate from hemorrhage and other stroke mimics and also to study the common vascular territory involvement in ischemic stroke and to note the common age group and sex in ischemic stroke, hemorrhage and other stroke mimics in 300 patients who were clinically suspected of stroke.

COMPARISON OF DWI AND CONVENTIONAL MR IMAGING IN ACUTEINFARCTS :

The total number of acute infarcts in our study is 148. Both conventional T2W and DWI sequences were positive in 84 (56.75%). Acute infarcts see only on diffusion and not visualized in conventional imaging T2W were 64 (43.25%).

Out of the 84 lesions also seen on conventional imaging, the extent of the lesions were better detected with diffusion imaging. The 64 infarcts picked up only by diffusion weighted imaging presented within 6 hours (mean of 4.35 hours) of symptom onset to our hospital.

Mullins ME, et al, in his study on 691 patients observed 97% sensitivity and 100% specificity with DWI; 58% sensitivity and 100% specificity with conventional MRI and 40% sensitivity and 92% specificity with CT. Lansberg et al Nin his study to determine yield of adding DWI to conventional MRI protocol for acute stroke observed 50.60% sensitivity and 46.59% specificity using conventional MRI as compared with DWI.These results are consistent with our results and substantiate the superiority of DWI over conventional MR imaging.

CONCLUSION

1. DWI should be included in the protocols of all MR Brain studies.
2. Correlation between DWI – MRA images is very much useful and will be helpful for further management.
3. MRI is noninvasive and there is no radiation hazard. Excellent grey-white matter resolution and multiplanar imaging capability of MRI help in detection of subtle lesions. The sensitivity of MRI to altered water content allows earlier detection of infarcts with DWI.
4. Our study observed that diffusion weighted imaging add sensitivity and specificity to the standard MR evaluation. DWI makes an important contribution to stroke management. DW imaging with restricted diffusion helped in the evaluation of acute infarcts in the setting of multifocal infarcts, lacunar infarcts and white matter ischemic changes responsible for patient's symptomatology and in distinguishing acute from subacute and chronic infarcts.

Though CT is considered as the imaging modality widely available at affordable cost, multimodal MRI has carved a niche as the feasible, cost-effective and time saving initially, state of ischemic stroke and has a definite role in the diagnosis and management of the same.

The limitation of this study is its lack of systematic follow-up neuroimaging. Another constraint is a selection bias; since not all patients clinically diagnosed as cerebrovascular accident routinely undergo DWI.

RESULTS

300 cases admitted in ASRAM hospitals, Eluru with the clinical diagnosis of cerebral ischemic stroke were taken up for the study. Out of 300 patients clinically suspected of cerebral ischemic stroke submitted for MRI scan study of brain.

232 patients had infarction 030 patients had hemorrhage 38 patients had stroke mimics Among those 77.3 % of the cases were infarcts.

Hemiplegia was the commonest presenting feature (45.33%).

Most commonly affected age group was 60-69 years (110 cases among the total study population).

Among the cases included in this study, 219 were males and 81were females.
Most commonly involved vascular territory is MCA (92 out of 232 cases).
Most common site of hemorrhage was basal ganglia (12 out of 30 cases).

Association between age group and type of stroke. In the 20-29 age group, all 100 % were lacunar infarcts. In the 80-89 age group, all 100 % were MCA infarcts. The association between age group and type of lesion is highly significant ($p<0.001$).

We found that areas of cerebral infarction have the high signal intensity and these lesions showed corresponding decreased signal on ADC maps, creation of ADC maps negates the T2 „shine through" effect that can contribute to lesion signal hyperintensity on diffusion weighted imaging.

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