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ROLE OF 3 TESLA MAGNETIC RESONANCE IMAGING IN THE EVALUATION OF DIFFUSE AXONAL INJURY OF BRAIN

Radio-Diagnosis

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ABSTRACT

Background: The objective of our study is to demonstrate the role of 3 Tesla MRI in detecting the diffuse axonal injury of brain. **Subject and methods.** It is a hospital based prospective observational study which is carried out in 35 patients with history of head injury referred to the department of Radio-diagnosis, Naryana Medical college. Patients having recent closed head injury with Glasgow coma Scale 12 and below and patients having neurological deficit in head injury with normal CT scan of brain, irrespective of mode of injury are included in the study. **Results:** Out of 35 patients, we correlated GCS, LOC, GOSE with the lesions in the various locations in brain. **Conclusion:** SWI is a better imaging sequence to detect DAI. MRI scores over the CT in diagnosing DAI. MRI has an added advantage of being non ionizing modality.

KEYWORDS

Diffuse axonal injury, grey-white matter junction, Susceptibility weighted Imaging, Glasgow Coma Scale.

INTRODUCTION

The term "diffuse axonal injury" refers to a sub-type of traumatic brain injury (TBI) caused by a direct brain injury.TBI is one of the common causes of death and disability in adolescents and young adults in United States.According to the Centers for Disease Control and Prevention (CDC), apprx. 1.5million cases of TBI have been reported in the United States each year.The true prevalence of DAI is unclear. However, 10% of all TBI patients admitted to the hospital are expected to have some degree of DAI.

It is estimated that approximately 25% of DAI patients will die. Because cases with SDH, EDH and other types of TBI do not have a true diagnosis of DAI, this statistic may be underestimated. Postmortem studies have revealed that patients with severe TBI have a high incidence of diffuse axonal injury[1].In the context of an appropriate clinical presentation, Computed Tomography (CT) brain findings of tiny haemorrhages to white matter tracts implies diffuse axonal injury[1]. Overall, the yield of CT head in diagnosing DAI and related injuries is low.DAI should be considered in patients who do not improve following surgical drainage of SDH or EDH. DAI may not be seen if patients dramatically improve upon surgical evacuation of subdural or epidural hematoma. Currently there are no laboratory investigations to diagnose DAI. However, there is currently research being conducted to identify molecular markers in the serum of patients with traumatic brain injury to aid in the diagnosis of DAI[1].

AIMS AND OBJECTIVES

1) To understand the significance of MRI in diffuse axonal injury of brain.
2) To enable the clinicians to co-relate the clinical manifestations & findings on MRI to predict the outcome.
3) To co-relate the duration of Loss of consciousness and Glasgow Coma outcome Scale in DAI of brain with findings on MRI.

MATERIALS AND METHODS:

This is a hospital based prospective study among 35 patients referred to the department of Radiodiagnosis, Narayana medical college, Nellore for a period of 18 months.

Inclusion Criteria

1.) Patients having recent closed head injury with Glasgow coma Scale 12 and below.
2.) Patients having neurological deficit in head injury with normal CT scan of brain, irrespective of mode of injury are included.

Exclusion criteria

1.) Patients having history of claustrophobia.
2.) Patients having history of metallic implants insertion, cardiac pacemakers and metallic foreign body insitu.
3.) Patients with open skull fractures.
4.) Patients with prior diagnosed neurological condition
5.) Patients under 18 years of age.

Statistical methods

Data is collected and compiled percentages are calculated. P value of less than 0.05 will be considered statistically significant. Numerical data were analyzed using the Chi-square test.

Method of study consists of :

A structured format containing patient details, clinical history, physical examinantion and investigations who meet the inclusion criteria were prepared and subjected to 3 Tesla MRI BRAIN(GE discovery750 w). Two groups of images were collected, magnitude images and phase images, which were loaded into the workstation for post-processing.

The site of hemorrhagic foci were identified by two experienced radiologists according to the characteristics of the focal distributions in combination with SWI and conventional methods.

Protocol:

- Axial T1 weighted images,
- Axial T2 weighted images ,
- Axial Fluid Attenuation Inversion Recovery (FLAIR),
- Axial Suspectablity Weighted Images (SWI) and
- Axial Diffuse Weighted Images(DWI).

All images were assessed by an attending neuroradiologist and neurosurgeons, in which the former was blinded to the clinical status of the patients.

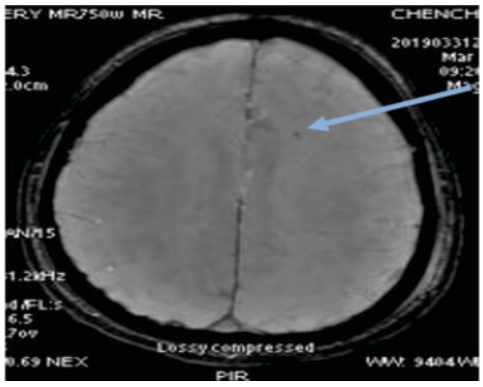
The Lesions were evaluated in the following sites - Corpus callosum, Frontal, temporal lobes, Basal ganglia ,Thalamus and BrainStem. Appearance of the lesions

- Blooming on SWI sequences
- Surrounding FLAIR hyperintensities.

GCS was assessed for each patient at the time of admission and outcome was assessed in each patient after six months using **Glasgow Outcome Extended Scale (8 point scale).**

Reference Cases

Case 1.



A

32 year old male who had fallen from motor bike presented to emergency OPD after 6 hours with loss of consciousness. E3V2M3 - GCS at presentation is 8.

- Plain CT brain shows no significant abnormality.
- FIG A - Further MRI Brain revealed - Tiny foci of blooming on SWAN noted at grey white matter junction in para-sagital region of left frontal lobe(arrow). Same case shows foci of blooming noted in left lentiform nucleus

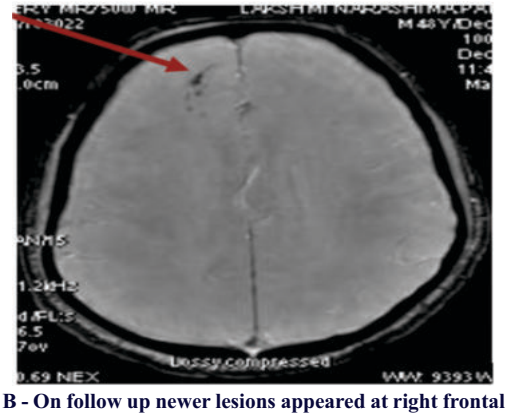
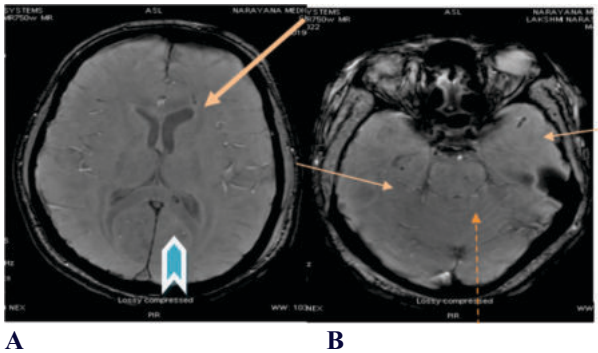


FIG B - On follow up newer lesions appeared at right frontal lobe (arrow).

Case 2



A **B**

45 yr.old male who had history of motor vehicle collision came to our hospital with loss of consciousness. On examination E2V2M3 - GCS 7.Fig.A- foci of blooming noted in periventricular region of left frontal lobe (long arrow) and splenium of corpus callosum (arrow head) in SWAN sequences.Fig.B- On subsequent scans, newer lesions seen at left half of pons (dotted arrow) and bilateral temporal lobes(arrows).

RESULTS

- Road Traffic Accident is the most comon mode of injury which is associated with DAI.
- In our study, most of the people belong to 50- 59 years age group.
- The study group showed predominance of GCS 8 and 9 and > 2/3rd patients were < 9 in GCS.
- Approximatly 50 % of study population had severe head injury as per GCS.
- Analysing the various lesions in MRI Findings, it is observed that most of them showed lobar lesions in SWI Sequence followed by corpus callosum, brain stem and deep grey nuclei(basal ganglia and thalami).
- In our study, most of the patients had lesions at multiple sites than single site lesion.
- To study the relationship between GCS on Admission and frequency of study population according to different sites of lesions in SWI in cases of DAI
- Relationship between the Site of lesion and GCS.

GCS	No. of patients with Lobar lesions	No. of patients with CC lesions	No. of patients with Brain stem lesions	No. of patients with Basal ganglia and thalami lesions	No. of patients with No lesions
3	2	2	2	2	0
4	3	3	3	3	0
5	3	3	3	1	0
6	4	4	4	0	0
7	5	5	1	0	0
8	5	4	0	0	0
9	5	1	0	0	1
10	1	0	0	0	1
11	2	0	0	0	0
12	0	0	0	0	1
total	30	22	13	6	3

- Patients with basal ganglia, thalamic, brain stem lesions have reduced GCS at the time of admission.
- Patients with corpus callosal lesions and those without any lesions have good GCS at the time of admission

VII) To study the relationship between duration of LOC and frequency of study population according to different site of Lesions in SWI in cases of DAI - Table no.11

Duration of LOC in days	Lobar lesions	CC lesions	Brainstem lesions	Basal ganglia and thalamic lesions	No lesions
1	0	0	0	0	1
3	1	0	0	0	0
5	2	0	0	0	0
6	0	0	0	0	1
7	3	1	0	0	0
8	1	0	0	0	0
9	1	0	0	0	1
10	4	2	0	0	0
11	0	1	0	0	0
12	1	1	0	0	0
15	1	1	0	0	0
17	1	1	0	0	0
20	1	1	0	0	0
22	1	1	1	0	0
24	1	1	0	0	0
30	1	1	1	0	0
35	1	1	1	0	0
39	2	2	2	0	0
40	2	2	2	0	0
42	1	1	1	1	0
50	1	1	1	1	0
52	2	2	2	2	0
55	1	1	1	1	0
60	1	1	1	1	0
Total	30	22	13	6	3

Patients with brainstem, basal ganglia and thalamic lesions in addition to lobar and corpus callosal lesions had longer duration of loss of consciousness (LOC).

- Study about GOSE in patients with DAI

- 5 patients died, GOSE being 1 .
- 7 patients had a GOSE Score of 2.
- 11 patients scored 3 and 4 in GOSE scoring
- 9 patients were in GOSE 5 and 6 with moderate disability.
- 3 patients were in GOSE 7 and 8 with good recovery.
- Most of the patients with basal ganglia, thalamic and brainstem lesions had poor prognosis with reduced GOSE. Patients who had good recovery had either no lesions or few lobar lesions.

DISCUSSION

This is a study of patients presented to Emergency and Neurology following closed head injury with very few or negative findings on CT Brain for a period of 18 months. These patients had loss of consciousness for several days to months. Few patients underwent MRI Brain on day1.And the remaining patients had MRI Brain at varied timings. All of them were followed up for a period of two months. As a suspicion of Diffuse Axonal Injury , SWI sequence with filter phase are included in addition to the standard protocol of MRI Brain in every patient. Location of haemorrhages were noted in all the patients. Correlation has been made between the duration of LOC, GCS with GOS, GOSE and the location of haemorrhages with long term prognosis .

Maximum number of patients of DAI in present study belonged to 50-59 years age group with clear cut male preponderance in DAI patients and male: female ratio of 32:3. RTA(constitutes about 68.5%) was the commonest cause of DAI followed by fall from height(constitutes apprx.22.85%)[9].Of 35 patients of diffuse axonal injury, SWI picked up lesions in 32 patients. The patients were scanned for SWI MRI on different days following injuries.

In this study of 35 patients, various data have been observed and analyzed.

The GCS of 35 patients were analyzed which showed 65.7% of patients had GCS less than 8 and 34.3% of patients were with GCS more than 8.

The highest percentage of Glasgow coma scale incidence was in GCS 8 and GCS 9. It corresponds to 17.1 and 20 % respectively.

In our study, patients with corpus callosal(22 patients- 62.8%) ,brain stem(13 patients-37.1%), basal ganglia and thalamic(6 patients-17.1%) lesions had low GCS($p < 0.05$) at the time of admission with longer duration of loss of consciousness($p < 0.05$) and had worse prognosis[10] as seen with reduced GOSE ($p < 0.05$) .

- Corpus callosal, brainstem, basal ganglia and thalamic lesions have severe brain injury which is seen as low GCS at the time of admission.
- It states that patients with corpus callosal, brain stem, basal ganglia and thalamic lesions had longer duration of LOC.
- It states that patients with corpus callosal, brain stem, basal ganglia and thalamic lesions have severe brain injury which is seen as low GOSE after follow up.

It is proven that higher grades of DAI had poor outcome in the form of reduced GOSE. Whereas patients with lobar lesions alone (25.7%)had lower GCS, longer duration of LOC, lower Severe Disability and Good Recovery GOSE which had non significant P values(>0.05).Hence, Null hypothesis is accepted. This is because most of the patients had combined brainstem and lobar lesions.This is a **limitation** in our study.

In present study, most of the patients (88.58%) of DAI belong to stage-II & stage-III on MRI findings. Our study reveals out of 35 patients , 5 patients with GCS of 3 on admission died on long term follow up after 50-60 days which constitutes approximatly 14.28% . And 2 (5.71%) patients with GCS of 11,12 had full recovery in the form of resolving lesions following 3 to 5 days of trauma.

Out of survivors(30 patients), 23 patients (76.6%)are dependent with GOSE of 2,3,4and 5.And 5 (16.6%)patients are independent with GOSE 6 and 7 and 2 patients(6%) had full recovery with GOSE 8.

Progression/resolution of lesions on follow up MRI scans as follows:

One of the patient with GCS 5 had developed newer lesions at lobar, corpus callosal, brainstem and basal ganglia sites. The remaining patients with GCS of 5 and 6 at the time of admission also developed newer lesions at all sites except at basal ganglia and thalamic sites. One of the patient with GCS scale 7 had developed newer lesions at lobar, corpus callosal, brainstem and basal ganglia sites. The remaining patients with GCS of 7 and 8 also developed newer lesions at all sites except at basal ganglia and thalamic sites. Two of the patients with GCS 8 had developed newer lesions at lobar and corpus callosum. The remaining patients with GCS 8 also developed newer lesions at all sites except at basal ganglia and thalamic sites. Patients with GCS of 9 and 10 at the time of admission had developed newer lesions only at lobar and corpus callosum.

CONCLUSION

MRI is the modality of choice to detect Diffuse Axonal Injury in the cases of negative CT Brain findings[7]. Especially Susceptibility Weighted Imaging (SWI) is the sequence of choice to detect haemorrhages in various locations apart from contusions[7,9].

In present study, maximum cases of DAI were recorded in age group of 20-40 years with male preponderence. The commonest mode of injury was road traffic accident followed by fall from height. Glassgow Coma Scale (GCS) has been recorded for every patient at the time of admission to grade the severity of injury following head injury.

Most of the DAI victims belonged to severe head injury group. Patients with Basal ganglia, thalamic and brain stem lesions had low GCS at the time of admission followed by patients with corpus callosum and lobar lesions.Patients with basal ganglia and brain stem lesions had longer duration of Loss Of Consciousness (LOC) followed by patients with corpus callosal and lobar lesions.

On follow up patients with basal ganglia and brain stem lesions had developed newer lesions resulting in poor prognosis which is recorded with reduced GOSE. Whereas patients with corpus callosal lesions had less durations of LOC (faster recovery)when compared to patients with patients with basal ganglia and brain stem lesions.

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