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RESEARCH ARTICLE

"EVALUATION OF CEREBRAL VASCULAR ACCIDENT PROTOCOL USING VARIOUS MAGNETIC IMAGING RESONANCE SEQUENCES"

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Ischemic Stroke, Hemorrhagic Stroke, Diffusion Weighted Image, Magnetic Resonance Imaging

Abstract

Aim: To evaluate the best result in stroke assessment using various MRI sequences.
Background: Stroke is considered as a major disorder in today's world. MRI is used for diagnosis of CVA patients. MRI can identify accurately hemorrhagic and ischemic stroke patients in the acute, subacute and chronic stage.
Hypothesis: Which sequence give detailed study of CVA in MRI?
Data sources: As a literature review project, the methods and materials which supports this project are based on previous publications of the literature, indexed on Pubmed-Medline, Medscape, AMED,CINAHL and SCIRUS from 2000-2010. A computerized database search was performed using the Oxford's University OxLIP + interface and each of the article and studies that met the criteria for that project was evaluated. Even the data is collected from the MGM Hospital of Navi Mumbai.
Result: In my study the findings were Diffusion MRI sequence was more sensitive for around 80% and FLAIR sequence was also specific (specificity near about 60%) for detection of early(Hyperacute to Acute) stroke cases. T2 axial sequences were more helpful in chronic stroke cases which is about 40% in specification along with GRE. FLAIR sequence was more helpful.
Conclusion: MRI diffusion sequence is more specific and sensitive in Hyper acute and Acute stroke cases and FLAIR is helpful in Chronic stroke cases.

Introduction:-

Magnetic imaging resonance is a relative maverick to the universe of indicative radiology.[1]

The picture nature of MR pictures is dependent upon having a solid, uniform static attractive field. Resistive electromagnets utilized in the beginning of clinical MR imaging were low field quality, commonly under 0.3 T. Perpetual magnets were able to do to some degree higher static field qualities and did not require the huge electrical power supplies and cooling frameworks of resistive magnets. Be that as it may, they were very overwhelming and

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for all intents and purposes constrained to a greatest static field of 1 T or littler. Superconducting magnets were in this manner presented, at first with field qualities on the request of 0.35 to 0.6 T. [2]

1.5 T has turned into the pillar for business MR imaging frameworks. With developing enthusiasm for useful MR imaging of the cerebrum dependent on BOLD complexity, it before long ended up clear that still higher field qualities were expected to boost changes with enactment, prompting the business usage of 3-T imagers beginning in 1998. [3]

The MR appearance of intense drain is mind boggling, yet with the fitting arrangement, intense discharge might be recognized accurately even inside the initial six hours of stroke. Infarcts might be exhibited on MR with more prominent affectability than CT utilizing certain successions, for example, liquid weakened reversal recuperation (FLAIR) or dissemination weighted imaging (DWI). Sadly FLAIR likewise demonstrates a lot progressively extra accidental white issue sores that may essentially add to perplexity as opposed to distinguish the new sore. [4]

Ischemic stroke is one of the major causes of death and disability.[5] Multimodal magnetic resonance imaging (MRI) is useful for diagnosing ischemic stroke and for determining treatment strategies in the acute phase.[6,7]

MRI sequences like FLAIR, DWI, GRE, T1 weighted images, T2 weighted images are used in detail to figure out the stroke images and the DWI application for stroke is also carried out.[8]

A typical stroke MRI protocol consists of T2/FLAIR-, T2*-, diffusion- (DWI) and perfusion- (PWI) images and MR angiography (MRA). This protocol can be performed in less than 30 minutes. On T2-weighted and FLAIR images, ischemic infarction appears as a hyperintense lesion usually seen within the first 3–8 hours after stroke onset. In a recent study of acute ischemic stroke patients studied by MRI within 6 hours of symptom onset, patients without a visible hyperintense lesion on FLAIR images had greater than 90% probability of being imaged within the first 3 hours of symptom onset.[9-11]

FLAIR images are also highly sensitive to subarachnoid hemorrhage as well as acute cerebral venous sinus thrombosis. T2-weighted and FLAIR images are both used to assess older cerebral infarctions and the extent of concomitant small vessel disease [12,13].

MRI protocol is set for diagnosing the CVA case. A good protocol involves T1 weighted, T2 weighted, FLAIR, DWI, SWI and MRA.

Diffusion Weighted MRI provides image contrast that is dependent on the random microscopic motion of water protons. DW MRI uses a T2-weighted pulse sequence with two extra gradient pulses which is equal in magnitude and opposite in path. These gradient pulses are applied in between the nuclear spin excitation and data acquisition. Therefore, imaging is more sensitive. Higher water diffusion will result in greater signal attenuation and appears darker on the image.

FLAIR is a inversion recovery sequence. In FLAIR, the signal from fluid is suppressed. Inversion recovery sequence with a long inversion time (TI) of 2000-2500 is used for fluid suppression. This sequence is commonly used in the brain and spinal cord where the lesions are normally covered by bright cerebrospinal fluid (CSF) signals. A long inversion time suppresses the high CSF signal and improve the visualization of small periventricular and spinal cord lesions.[16]

Aims And Objectives:-

The main aim of this project is:

To evaluate the best result in stroke assessment using various MRI sequences.

The objective of this project is listed below:

1. To assess stroke in detail comparing various MRI sequences like FLAIR, DWI, T1, T2 weighted images.
2. To acquire best image quality of stroke using MRI parameters.
3. To comprehend the points of interest which will be assessed.
4. The Information which is given from MRI in regards to stroke patients will be broken down and assess, how these data can assist the clinician with the fundamental data which needs to continue to the fitting treatment.

Method And Materials:-

Source of information:
Information for my thesis was gathered from patients who came from casualty neurological OPD in MGM MEDICAL HOSPITAL, Kamothe, Navi Mumbai for MRI brain with history of stroke or cerebral vascular attack.

Method of gathering of information:
A graphic correlational examination was carried out over a time of eight months on multiple patients with manifestations of mind discharge. They were assessed with magnetic resonance imaging (Toshiba 1.5T MRI).

Research strategy:
The techniques and materials which was utilized to help my research was therapeutic books and diaries. The distributors like pubmed-medline, medscape, AMED, CINAHL and SCIRUS somewhere in the range of 2000 and 2010 utilizing the Oxford's college OxLP + interface and every one of the articles was made used. Watchwords and terms like stroke imaging, MRI, CT in stroke, ischemic hemorrhagic stroke finding, ischemic obscuration, thrombolysis was utilized from the internet searcher.

Inclusion criteria:
1. Patients above the age of 18.
2. Patients referred for MRI scan for brain plain with stroke referred from neurological OPD or IPD.
3. Patients referred from outside MGM hospital for MRI Scan for CVA cases.
4. Patients willing for study.
5. Follow up stroke patients

Exclusion criteria:
1. Patients below the age of 18.
2. Patients not willing for examination/study.
3. Patients with metallic implants or any objects for MRI scan of CVA cases.
4. Claustrophobia patients for MRI scan.

Parameters to be measured:
In Stroke for clinical criteria I used NIHSS scale and in MRI I made use of ASPECT score board to identify the stroke cases. And for follow up stroke cases we can make use of clinical NIHSS scale .

Review Of Literature
It was identified that the MRI do not appear to substantially change stroke incidence approximately, as mandatory clinical definition of stroke did not significantly differ from a definition that included imaging findings.

The main advantages of MRI is full visualization of infarction that is seen in DWI and the brain coverage that allows the detection of small and completely but clinically related hypo perfusion areas. Imaging of the circle of Willis can be performed in three minutes with a MRA. No allergic reactions are expected. However, it is mandatory to the control of vital signs and the access to the patient during the MRI study. In addition, it takes some more effort to train technicians to evaluate MRI in stroke cases to establish an adequate work flow during the hyper acute phase of an ischemic stroke.[14]

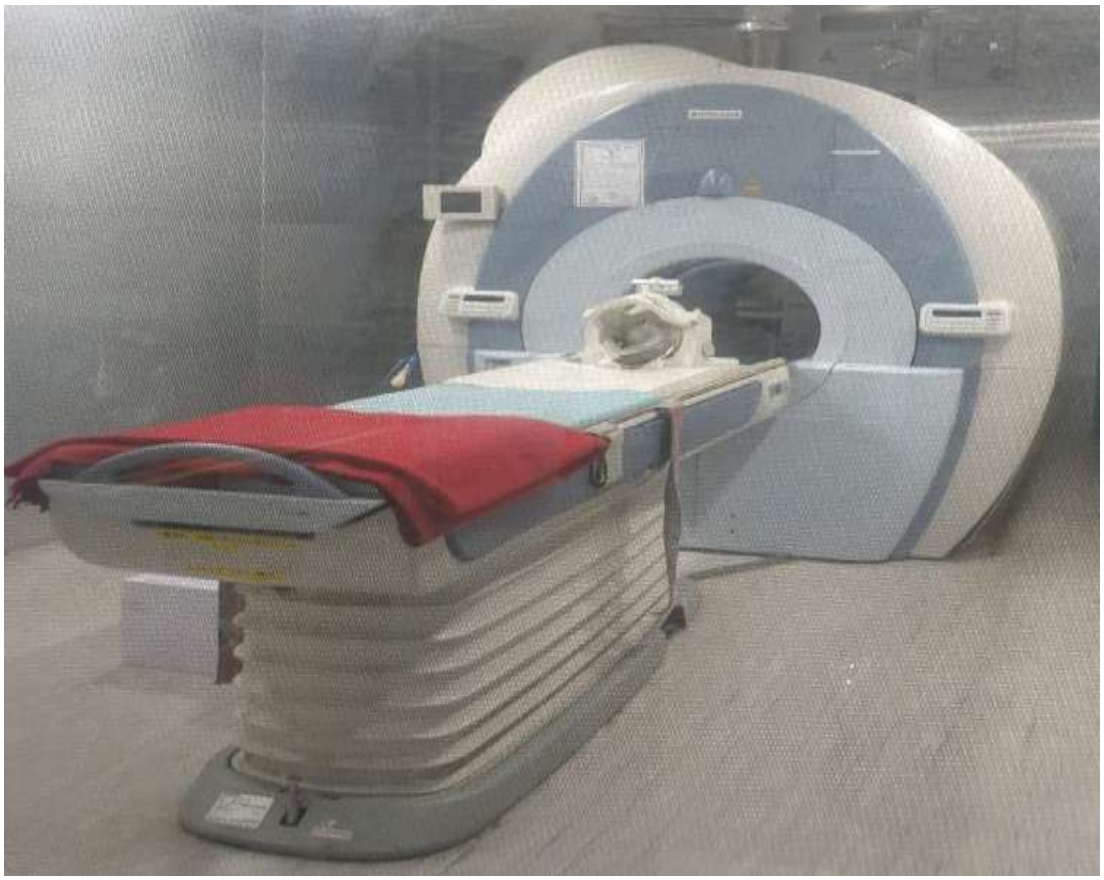
Evaluation of CVA MRI has been investigated in the clinical setting to evaluate its role for thrombolysis in an extended time. The DIAS and DEDAS trials used a new fibrinolytic drug, in acute ischemic stroke patients within a 3- to 9-hour window period after symptom onset. Patient screening was based on clinical examination, medical history and guided by CVA MRI. Only patients presenting a clear DWI mismatch were randomized. The patients who received a placebo or an ineffective dosage showed a low recanalization rate and an unfavorable outcome. Patients who achieved early vessel recanalization and reperfusion of penumbral tissue, showed a significant clinical benefit, and 60% of the patients from the more effective dose had an wonderful clinical outcome.[17]

Interrater medium for DWI-ASPECTS was slight for all and within each subspecialty. The dichotomization of DWI-ASPECTS (0–5 versus 6–10 or 0–6 versus 7–10), agreement between all raters reached a substantial level (0.62 [0.48–0.75] and 0.68 [0.55–0.79], respectively).[23]

Study Of Magnetic Resonance Imaging:

Magnetic Resonance Imaging

MRI is a electromagnetic device which uses strong magnetic field and radio waves to create specific images of human organs and tissues within the body with suitable protocols and parameters. It is a non invasive and painless device. The unit of Tesla was discovered by Serbian inventor "Nicola Tesla" (1856-1943), hence MRI unit was named as "Tesla".[1]



Paul C Lauterbur (1929-2007) is the Father of MRI. He is a professor of chemistry and radiology at New York University, he discovered the use of magnetic field gradients for spatial localization of MRI signals. Thus it led to the Foundation of MRI. He was awarded with Nobel price for physiology or medicine in 2003. There are even more scientists who are involved in evolution of MRI.[24]

Principle Of MRI

An MRI scanner consists of powerful magnets, helium and nitrogen. The human body is made up of water molecules, which are comprised of H2O (hydrogen and oxygen) atoms. Each hydrogen atom consist of even smaller particle called a proton, which serves as a magnet which is sensitive to any magnetic field in every human body.[2]

Eventually, the water molecules in every human body is randomly arranged, but when exposed to a MRI scanner, the magnetic field causes the water molecules to align in one direction, which can be either north or south. When the magnetic field is turned on and off in a series of quick pulses, it causing each hydrogen atom to move its alignment when switched on and then quickly switch back to its original state when switched off.

When the MRI is switched on the passing electricity through gradient coils causes the coils to vibrate, and creates the magnetic field, which eventually cause a knocking sound inside the scanner. Even though the patient cannot feel the changes, the scanner detects them and in connection with a monitor we can create a specific detailed cross-sectional images for the radiologist to diagnose the case. This is the basic principle of MRI scanner of how it works.

There are even contrast like Omniscan which is used in MRI to view the detailed images or organ especially the arteries and the veins can be studied in more detailed and the scan is non invasive.

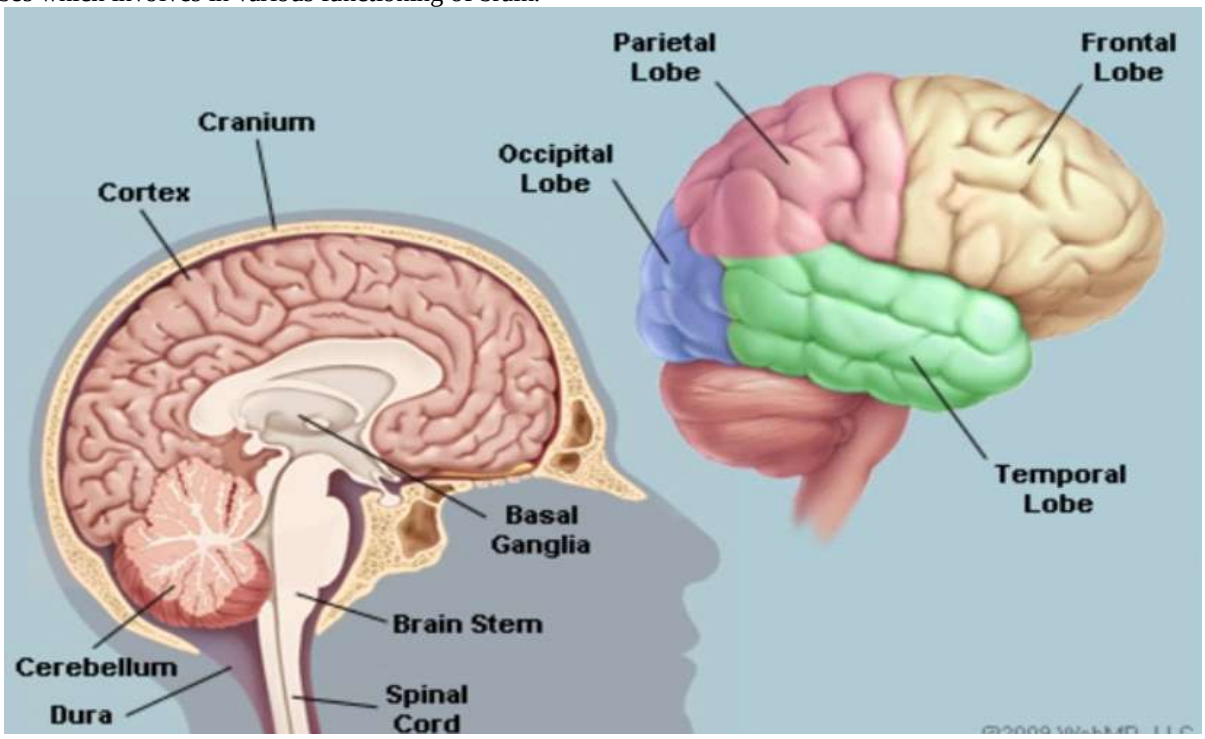
Points To Remember For MRI

1. Patient should have a prescription before MRI scan.
2. Patient should not carry any metallic objects with them.
3. Proper screening needs to be done before scan.
4. Don't allow with dental implants, orthopedic implants, cardiac pacemaker, any foreign implants with in body.
5. Change in to hospital gowns.
6. Not to carry mobile phones, credit or any cards, wallets, etc.
7. Don't allow claustrophobic patients.
8. Explain about the procedure in detail before entering the scan room.
9. Full body scan needs to done with metal detector equipment before entering into the restricted MRI scan room.
10. Consent form needs to be filled and signed by the patient or the relative before injecting any contrast for scan.
11. Sedative should be given only in presence of the physician for incorperative patients or old aged/children who moves during the scan period.[19]

Study Of Brain

Anatomy Of Brain

The brain is one of the most sensitive and complex organ of the human body part. It consist of more than 100 billion nerves that sends impulse reflexes which is in form of synapses. The brain has mainly 3 parts which is cerebrum, cerebellum and brain stem. Where the cerebrum is the largest part of the whole human brain. Cerebrum divides into two parts left hemisphere and right hemisphere, these hemispheres are separated by the corpus callosum which lies in between the hemispheres. The brain stem is further more divided into 3 parts named midbrain, pons and medulla oblongata. The brain is also divided into 4 lobes such as frontal lobes, parietal lobes, temporal lobes and occipital lobes which involves in various functioning of brain.

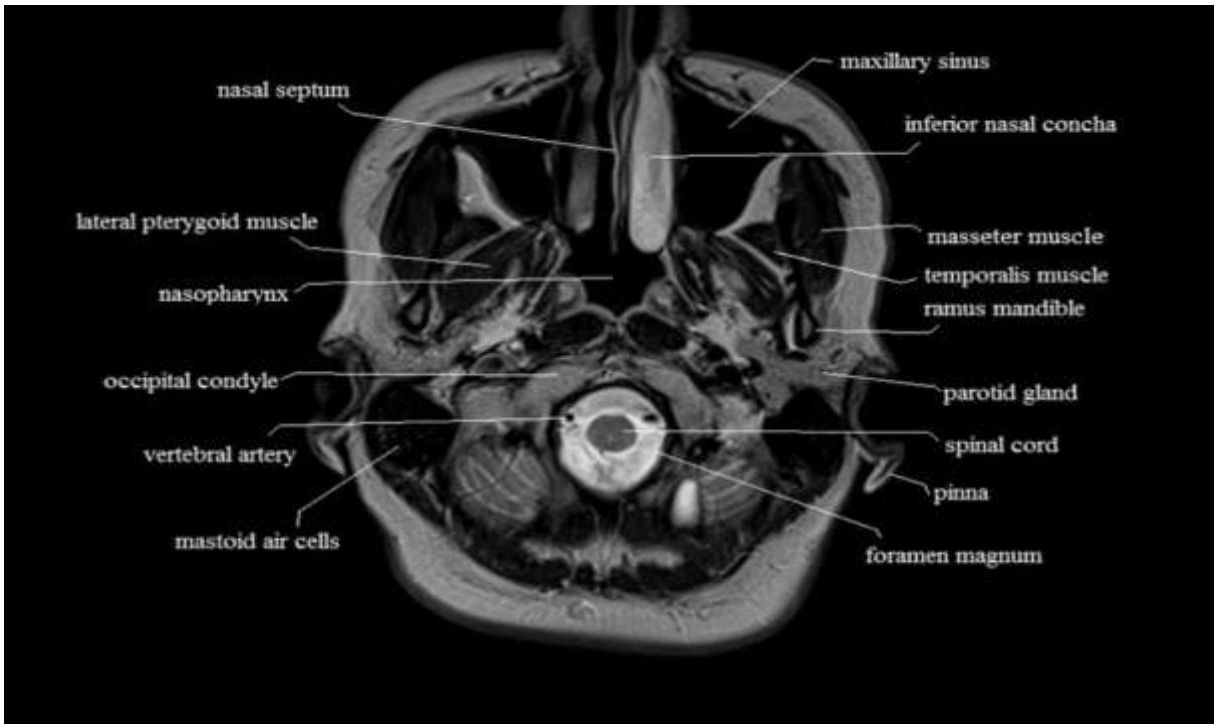


Human brain is protected by the skull bone which covers and protect the brain organ. There are 3 layers of brain called Meninges, which lies between the skull and the brain organ, those are the outermost layer known as dura mater, the middle layer known as arachnoid mater and the inner most layer known as the pia mater. Human brain consist of 4 ventricles such as right lateral ventricle, left lateral ventricle, third ventricle and the fourth ventricle. The main gland the lies at the base of the brain which secretes hormones is called as the pituitary gland.[20]

Basic Anatomy of Brain
Functions Of Brain

SR.NO	PART OF BRAIN	FUNCTIONS
1.	Cerebrum	Process in vision, hearing, speech, emotions and movement.
2.	Left hemisphere	Process motor and sensory signals of right side body parts.
3.	Right hemisphere	Process motor and sensory signals of left side body parts.
4.	Corpus callosum	Connects the right and left hemispheres.
5.	Frontal lobe	Helps in reasoning movement and emotions.
6.	Parietal lobe	Helps in understanding, touch and pain.
7.	Occipital lobe	Process in visual information.
8.	Temporal lobe	Functions in memory, language, smell and emotions.
9.	Cerebellum	Controls motor movements, posture and balances.
10.	Brainstem	Controls functions for survival.
11.	Midbrain	Controls hearing, eye movements, facial sensation and balance.
12.	Pons	Process sensory analysis, sleep, consciousness and motor skills.
13.	Medulla oblongata	Controls respiratory drive, blood pressure, gag reflux and swallowing.
14.	Thalamus	Integrates sensory signals.
15.	Hypothalamus	Regulates temperature, thirst, sleep and hormone productions.
16.	Pituitary gland	Secretes hormones.
17.	Basal ganglia	Helps in steady movements.

Axial View Of Brain



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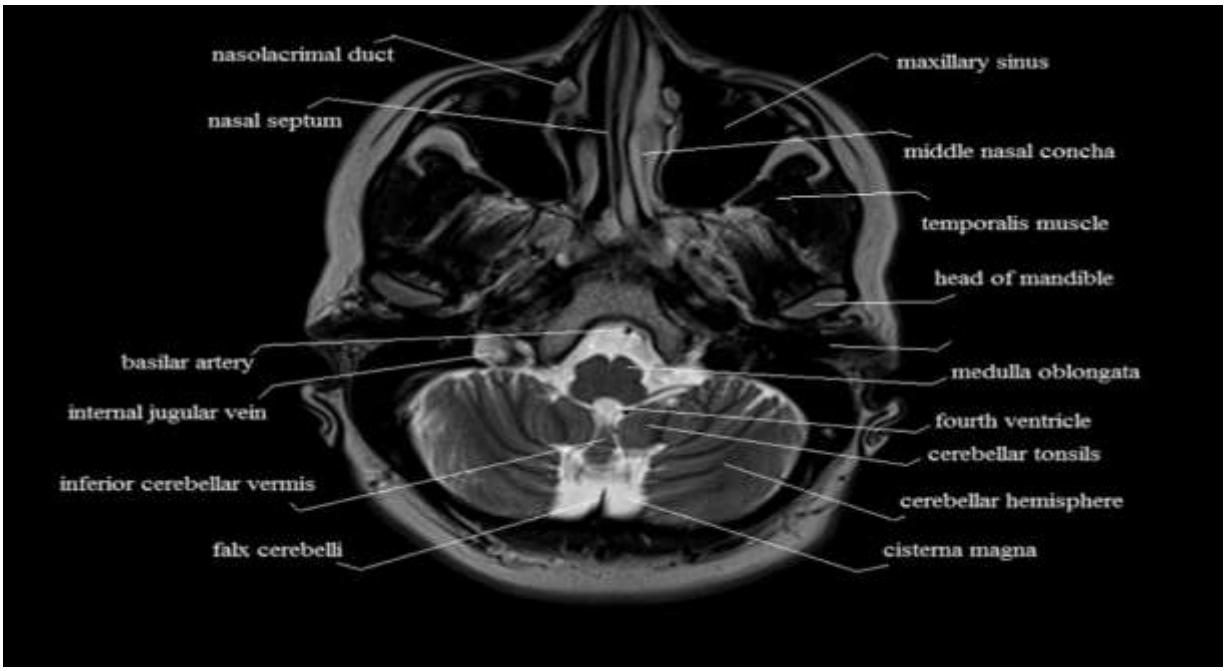
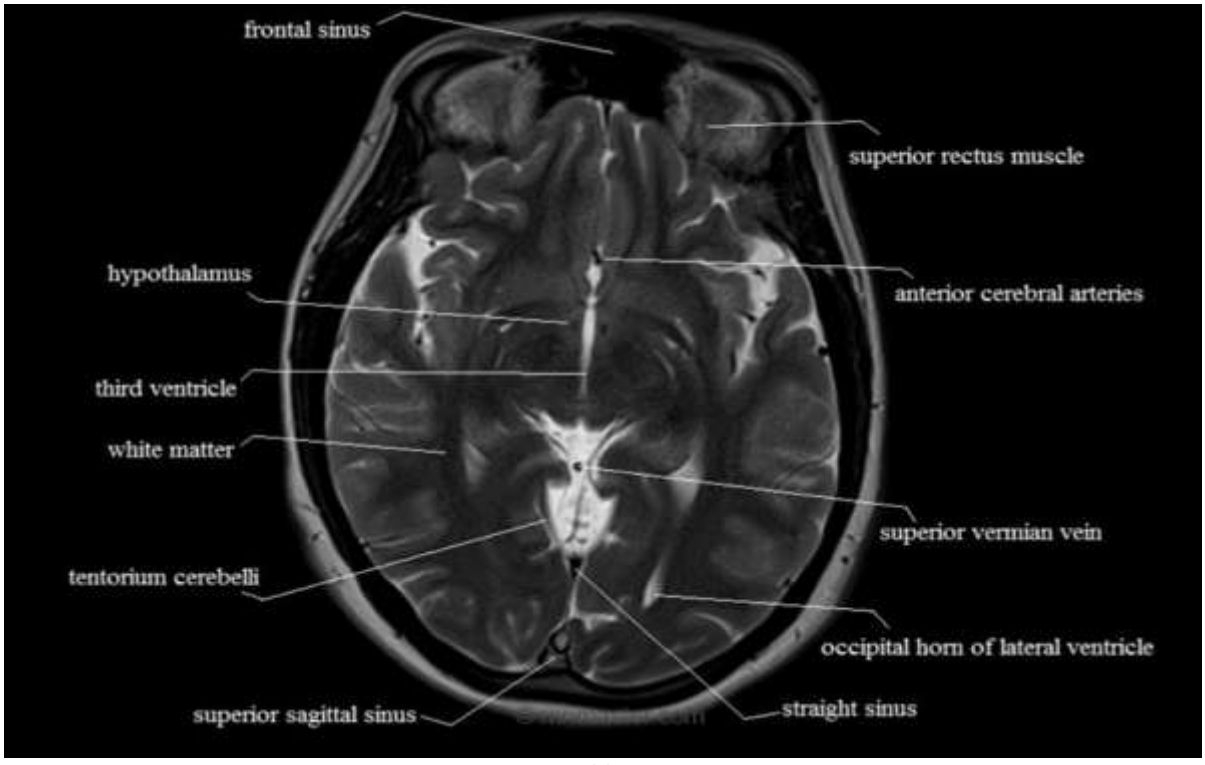
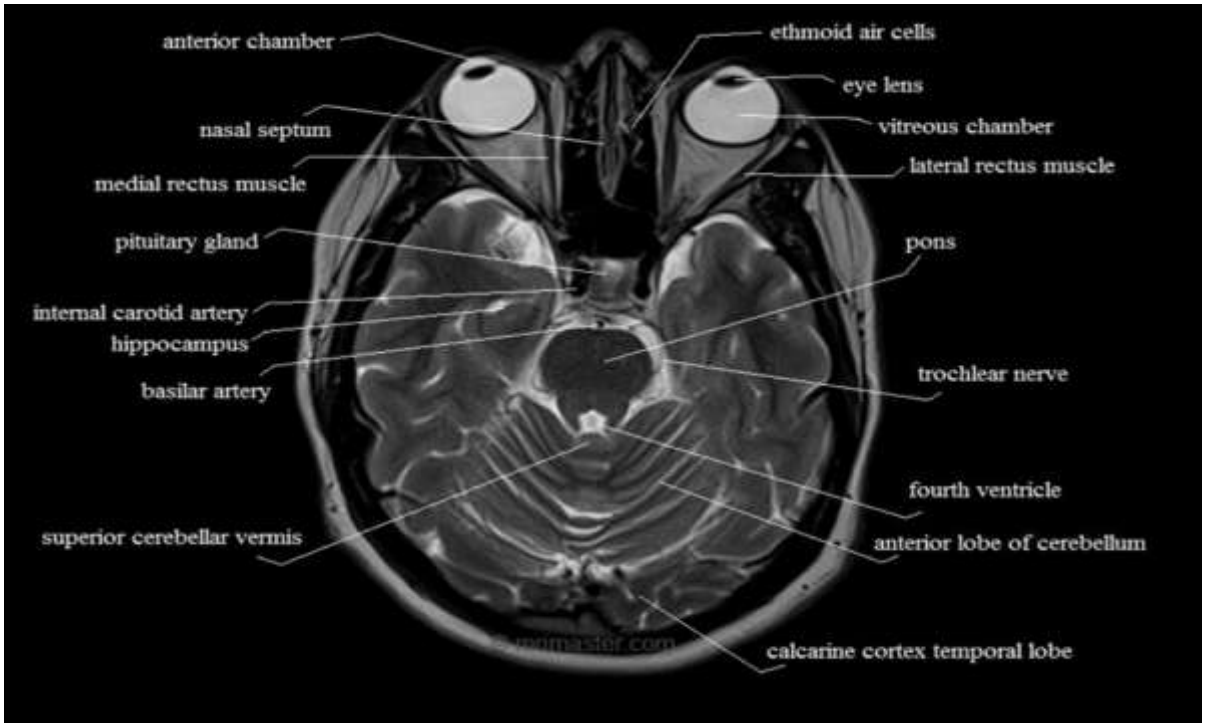

nasolacrimal duct
nasal septum
maxillary sinus
middle nasal concha
temporalis muscle
head of mandible
basilar artery
internal jugular vein
medulla oblongata
fourth ventricle
cerebellar tonsils
inferior cerebellar vermis
cerebellar hemisphere
falx cerebelli
cisterna magna

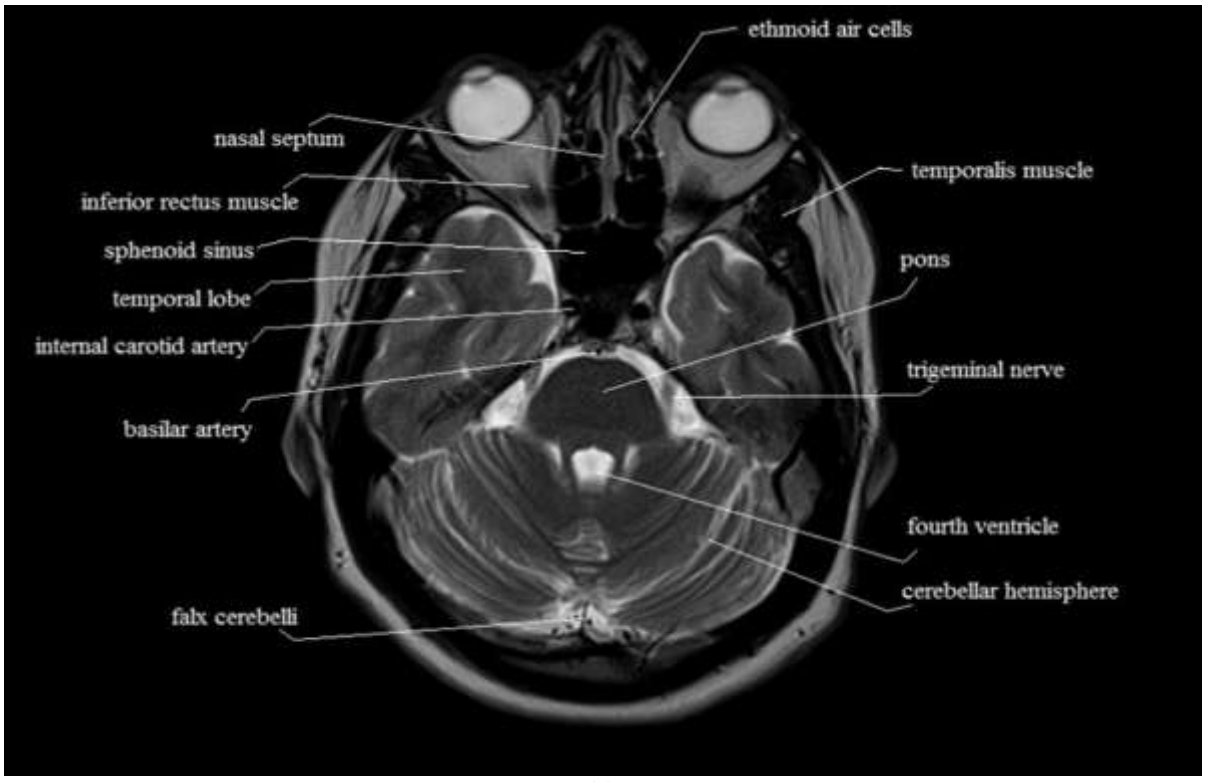
(b)


frontal sinus
superior rectus muscle
hypothalamus
anterior cerebral arteries
third ventricle
white matter
superior vermian vein
tentorium cerebelli
occipital horn of lateral ventricle
superior sagittal sinus
straight sinus

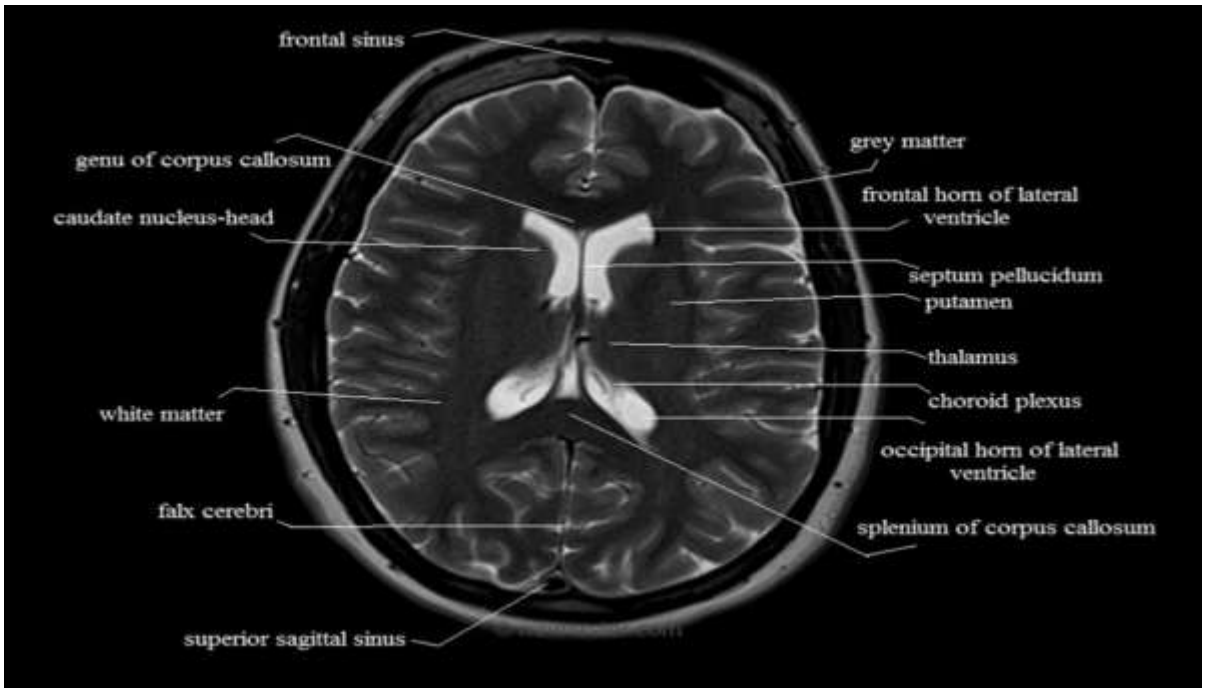
(c)


anterior chamber
ethmoid air cells
eye lens
nasal septum
vitreous chamber
medial rectus muscle
lateral rectus muscle
pituitary gland
pons
internal carotid artery
hippocampus
basilar artery
trochlear nerve
fourth ventricle
superior cerebellar vermis
anterior lobe of cerebellum
calcarine cortex temporal lobe

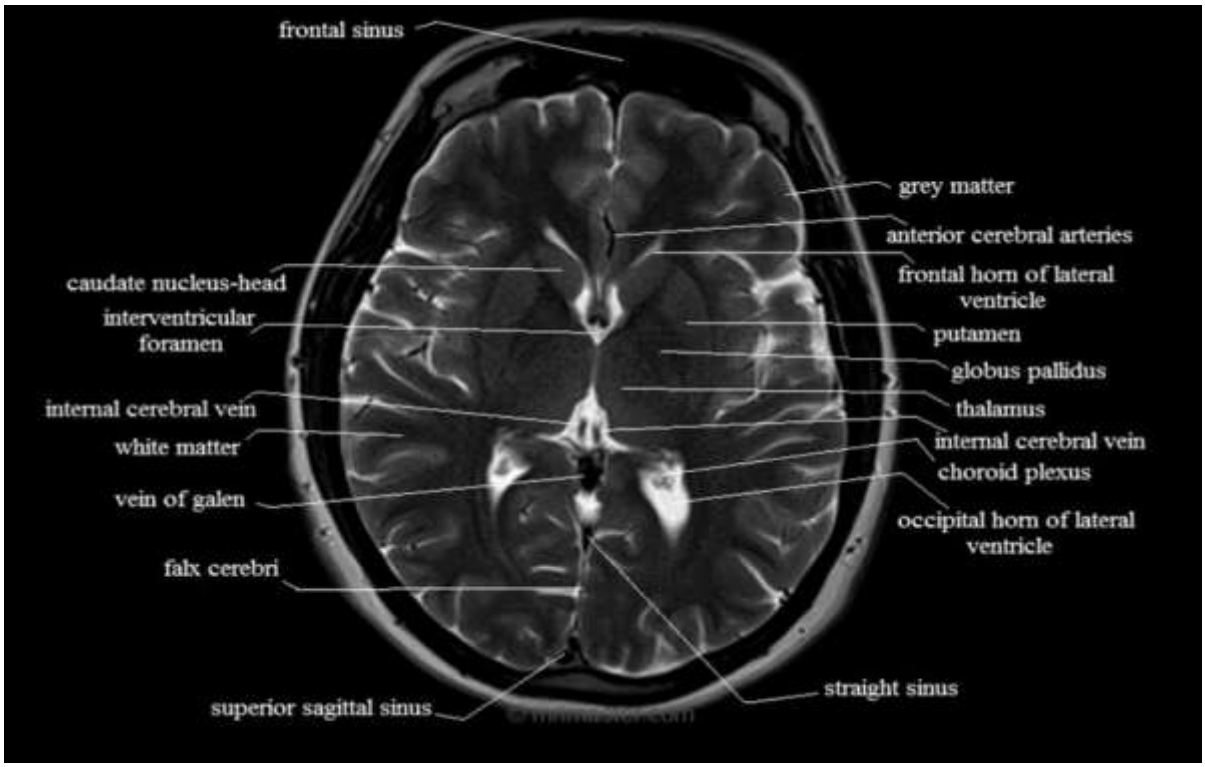
(d)


ethmoid air cells
nasal septum
temporalis muscle
inferior rectus muscle
sphenoid sinus
pons
temporal lobe
internal carotid artery
trigeminal nerve
basilar artery
fourth ventricle
cerebellar hemisphere
falx cerebelli

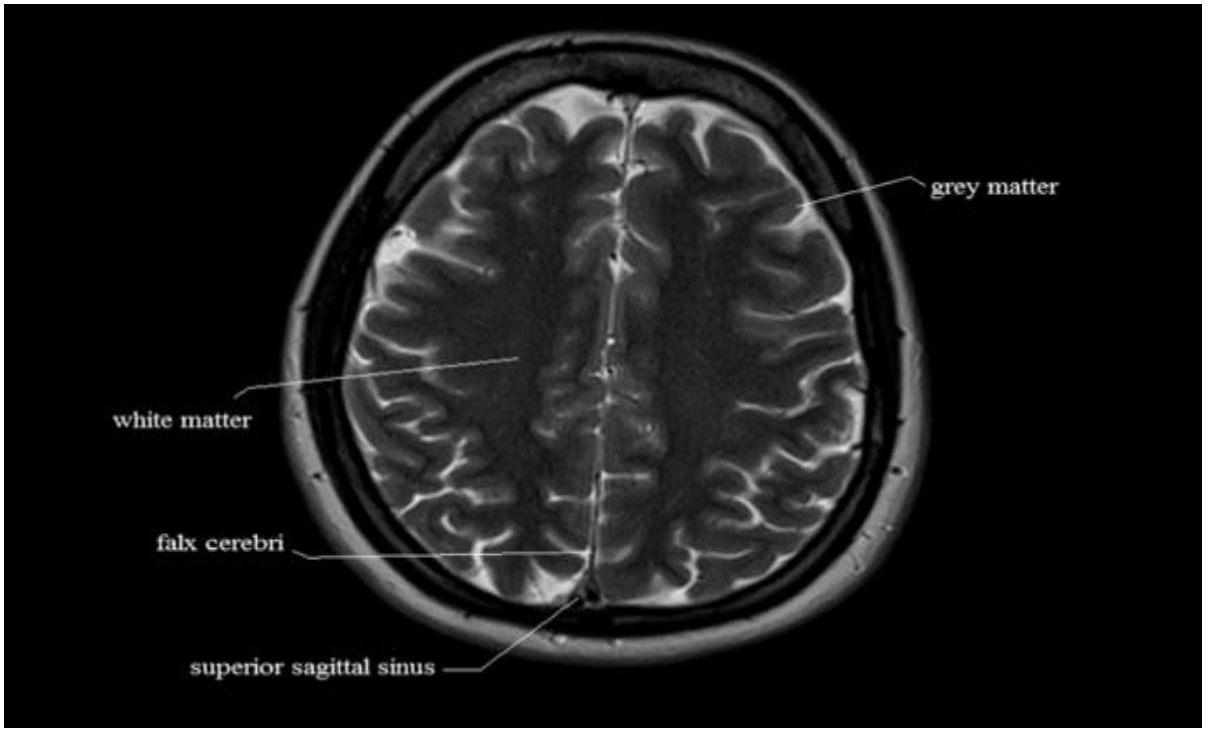
(e)


frontal sinus
genu of corpus callosum
caudate nucleus-head
grey matter
frontal horn of lateral ventricle
septum pellucidum
putamen
thalamus
choroid plexus
occipital horn of lateral ventricle
splenium of corpus callosum
white matter
falx cerebri
superior sagittal sinus

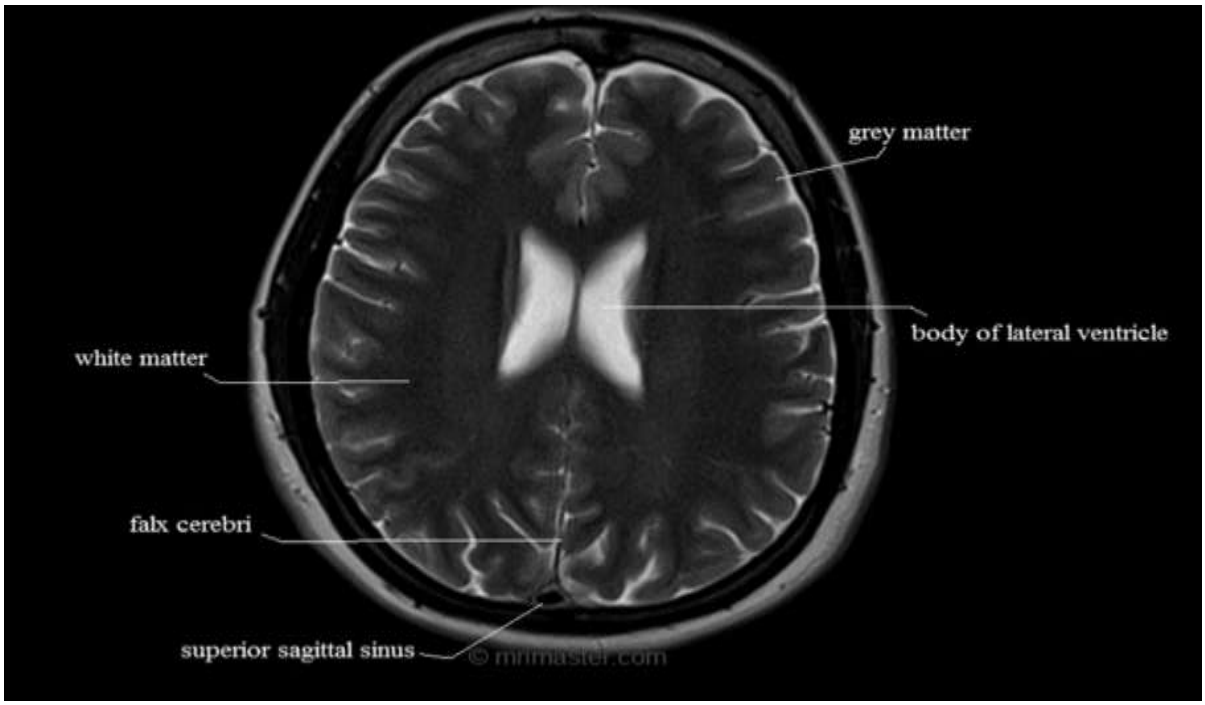
(f)


frontal sinus
grey matter
anterior cerebral arteries
frontal horn of lateral ventricle
caudate nucleus-head
interventricular foramen
putamen
globus pallidus
thalamus
internal cerebral vein
white matter
internal cerebral vein
choroid plexus
vein of galen
occipital horn of lateral ventricle
falx cerebri
straight sinus
superior sagittal sinus

(g)


grey matter
white matter
falx cerebri
superior sagittal sinus

(h)


grey matter
body of lateral ventricle
white matter
falx cerebri
superior sagittal sinus
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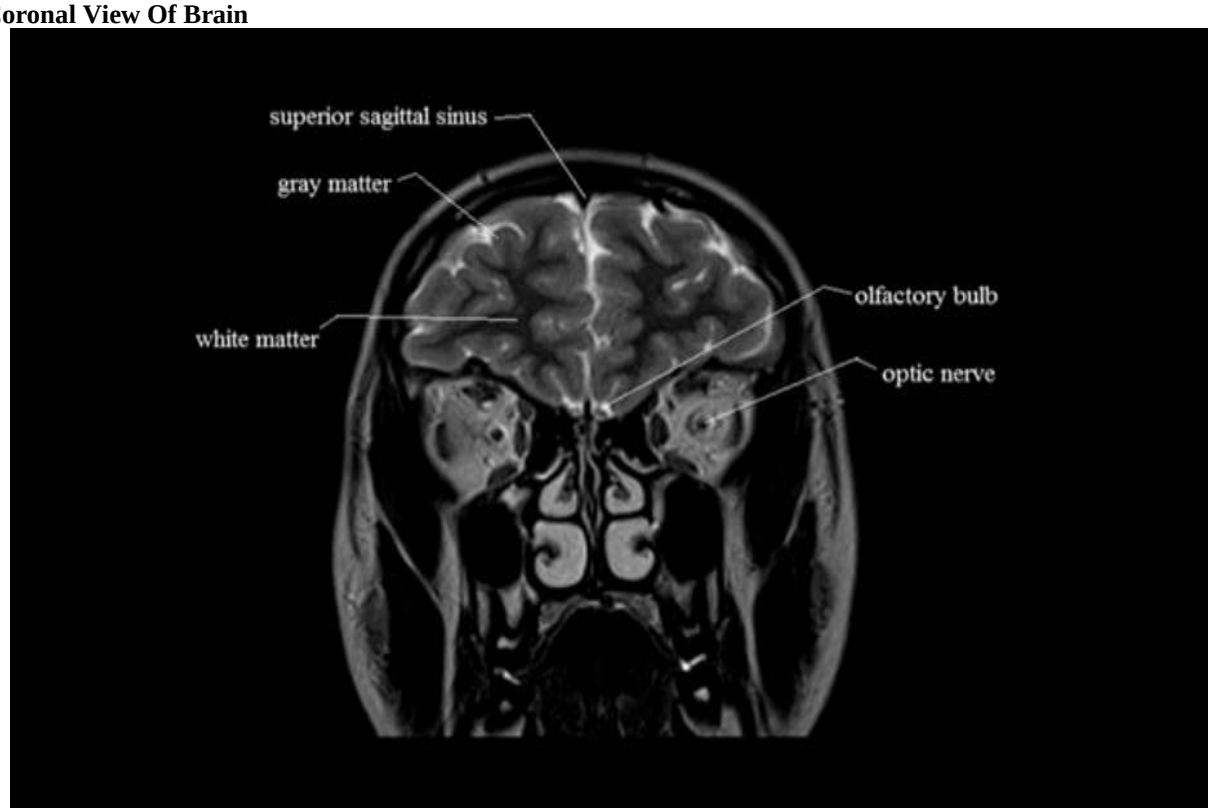
Coronal View Of Brain



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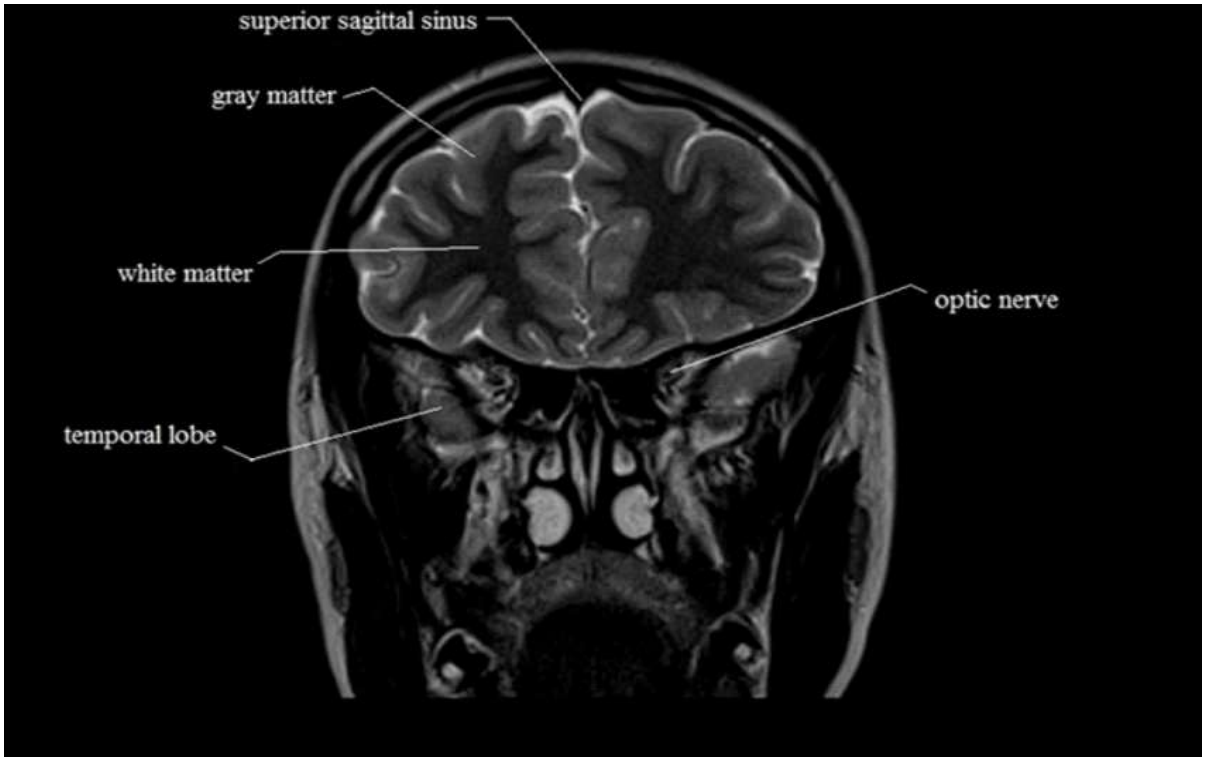

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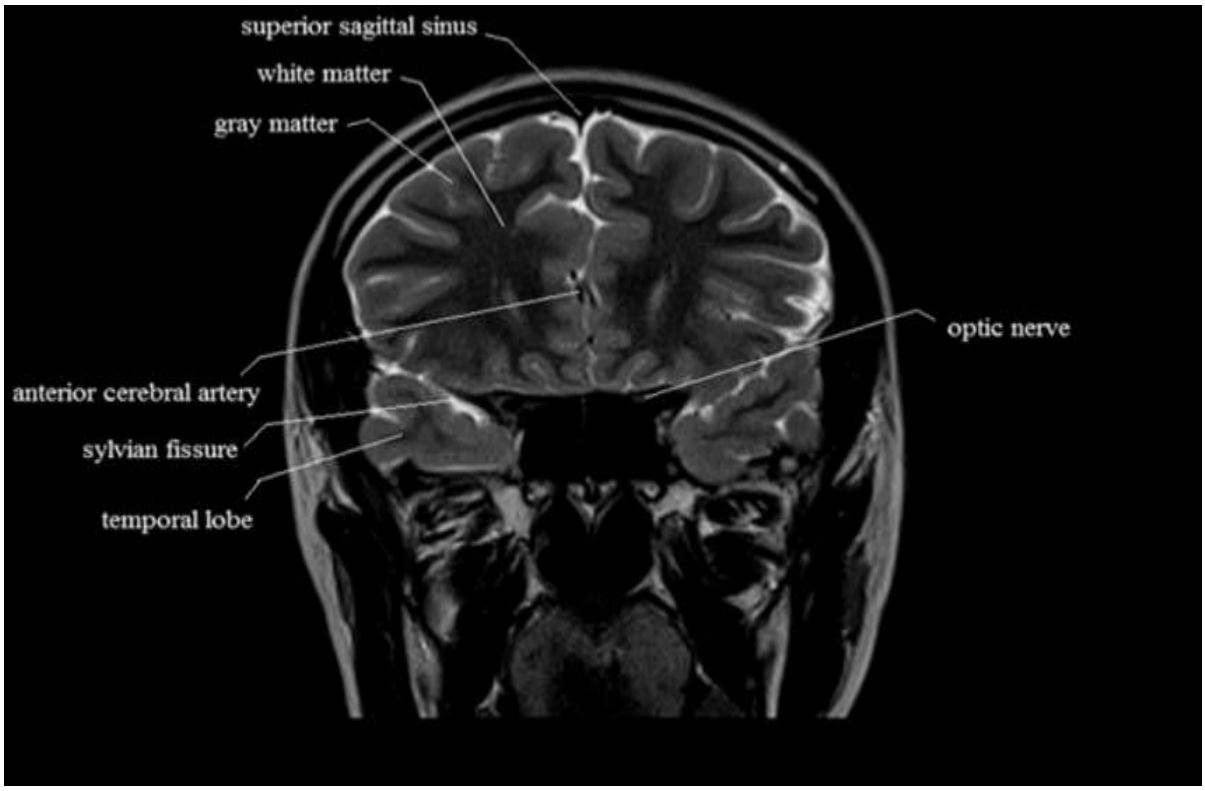
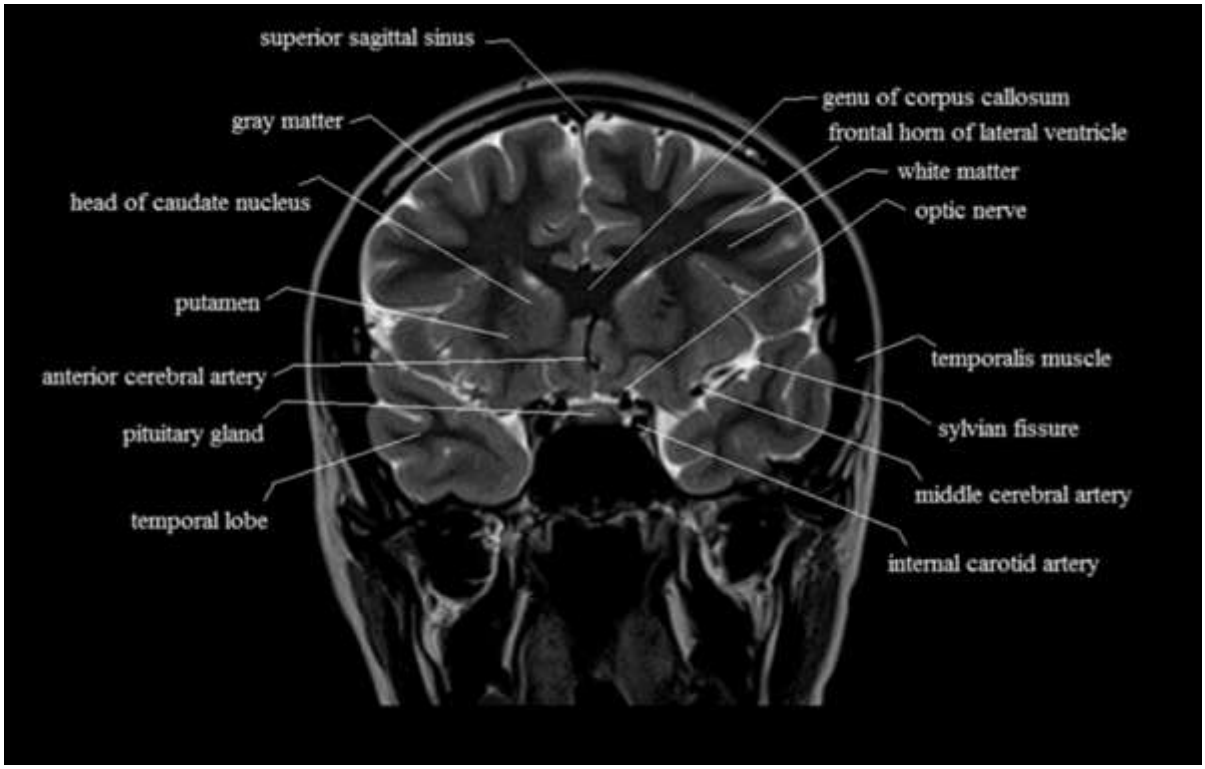
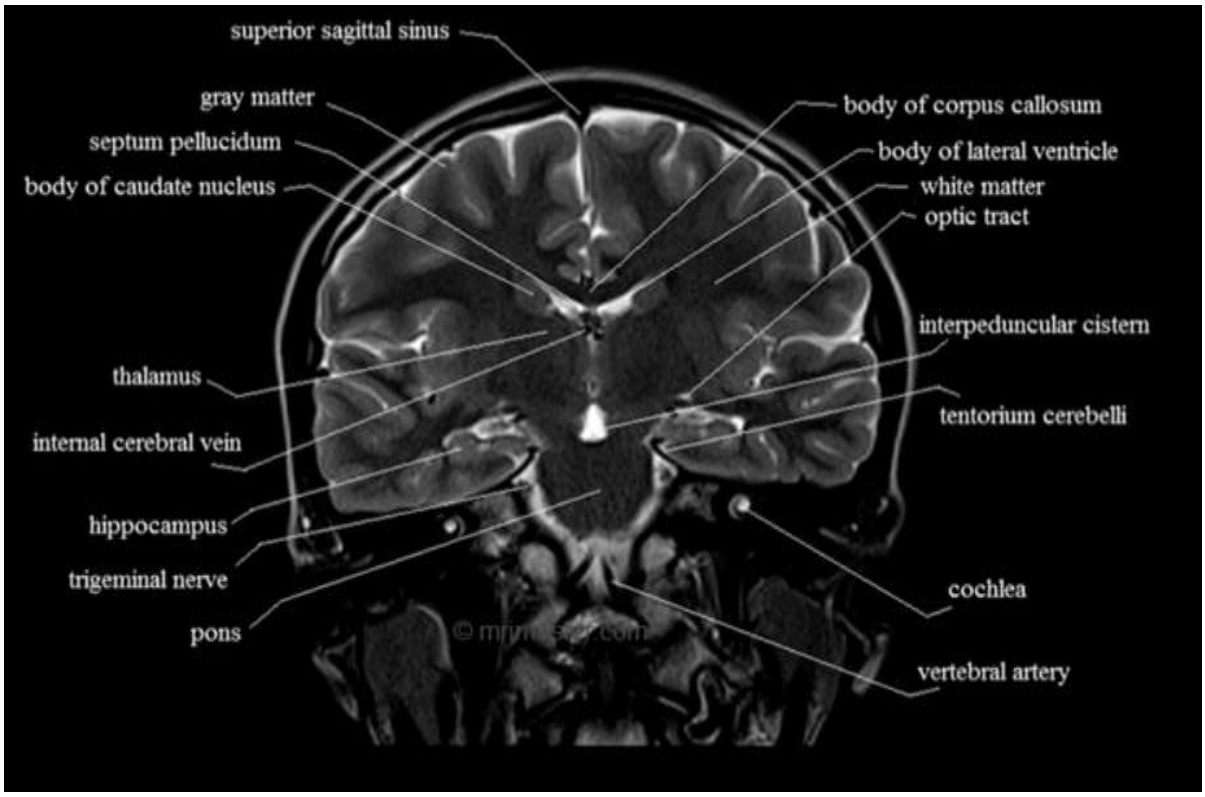

superior sagittal sinus
white matter
gray matter
optic nerve
anterior cerebral artery
sylvian fissure
temporal lobe

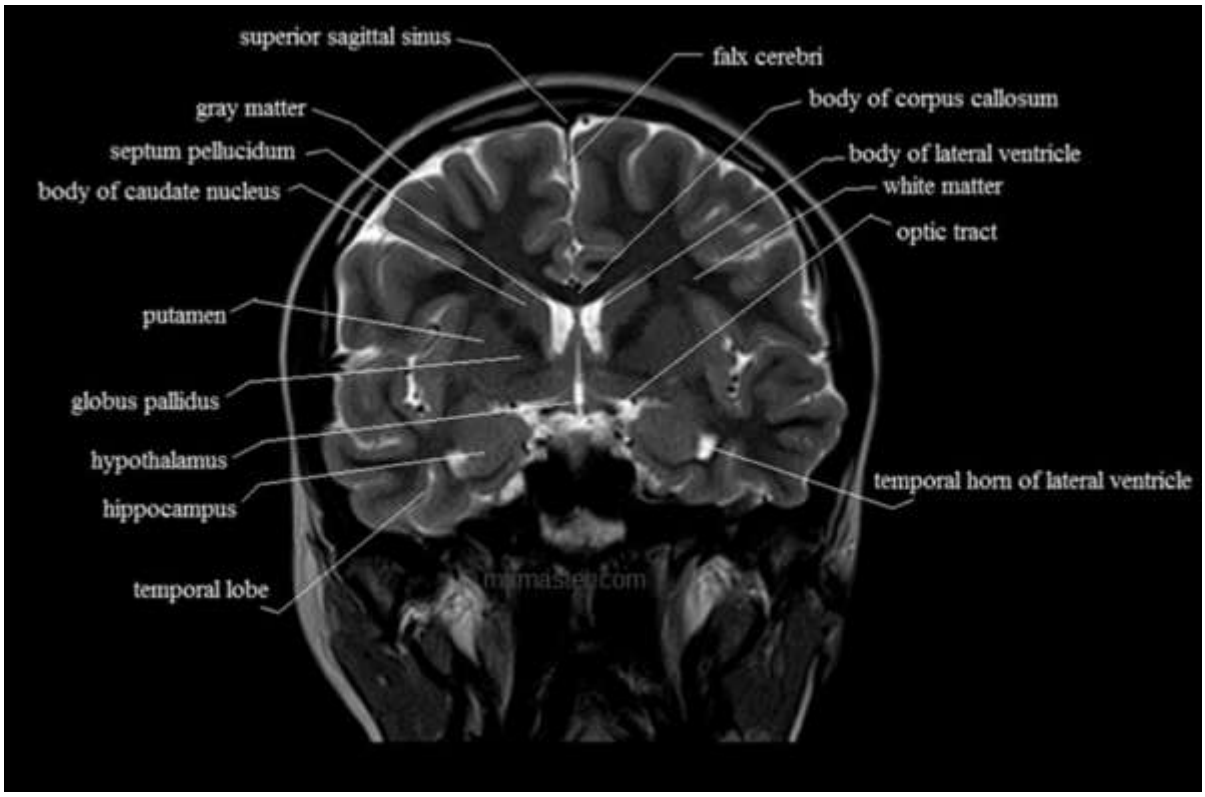
(c)


superior sagittal sinus
genu of corpus callosum
gray matter
frontal horn of lateral ventricle
white matter
head of caudate nucleus
optic nerve
putamen
temporalis muscle
anterior cerebral artery
sylvian fissure
pituitary gland
middle cerebral artery
temporal lobe
internal carotid artery

(d)


superior sagittal sinus
gray matter
septum pellucidum
body of caudate nucleus
thalamus
internal cerebral vein
hippocampus
trigeminal nerve
pons
body of corpus callosum
body of lateral ventricle
white matter
optic tract
interpeduncular cistern
tentorium cerebelli
cochlea
vertebral artery

(e)


superior sagittal sinus
falx cerebri
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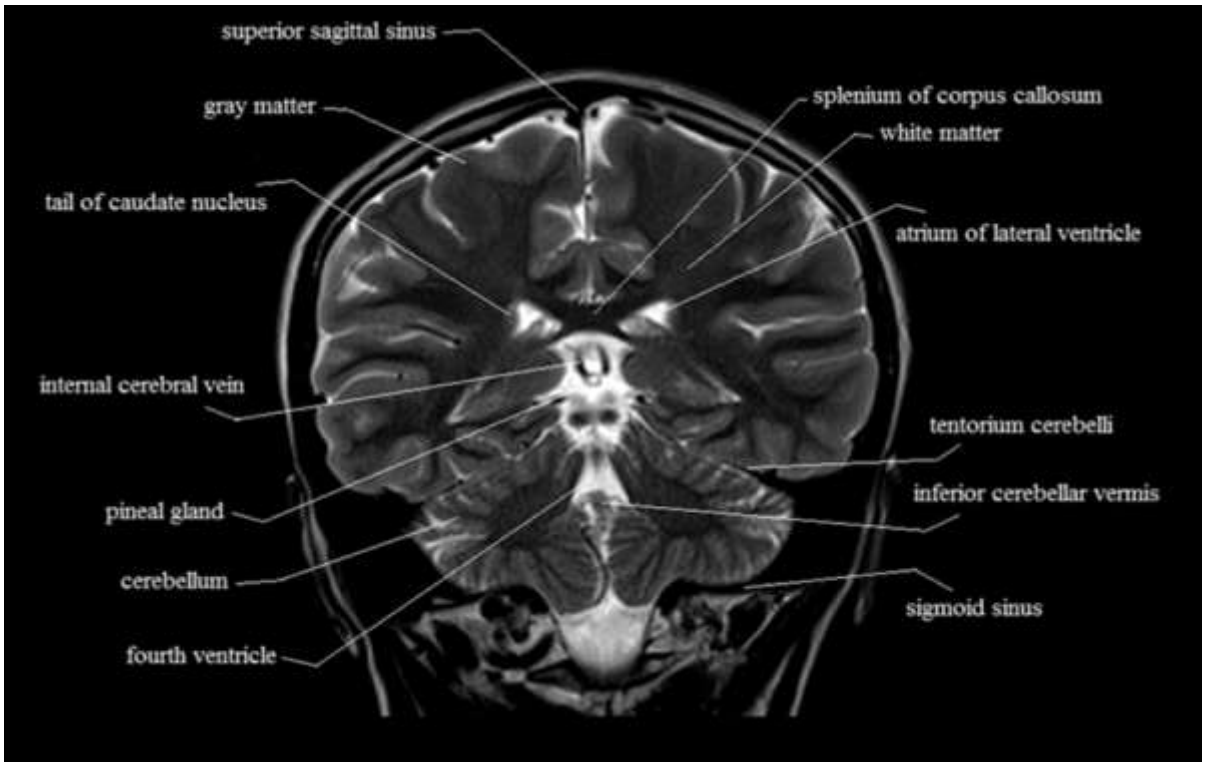
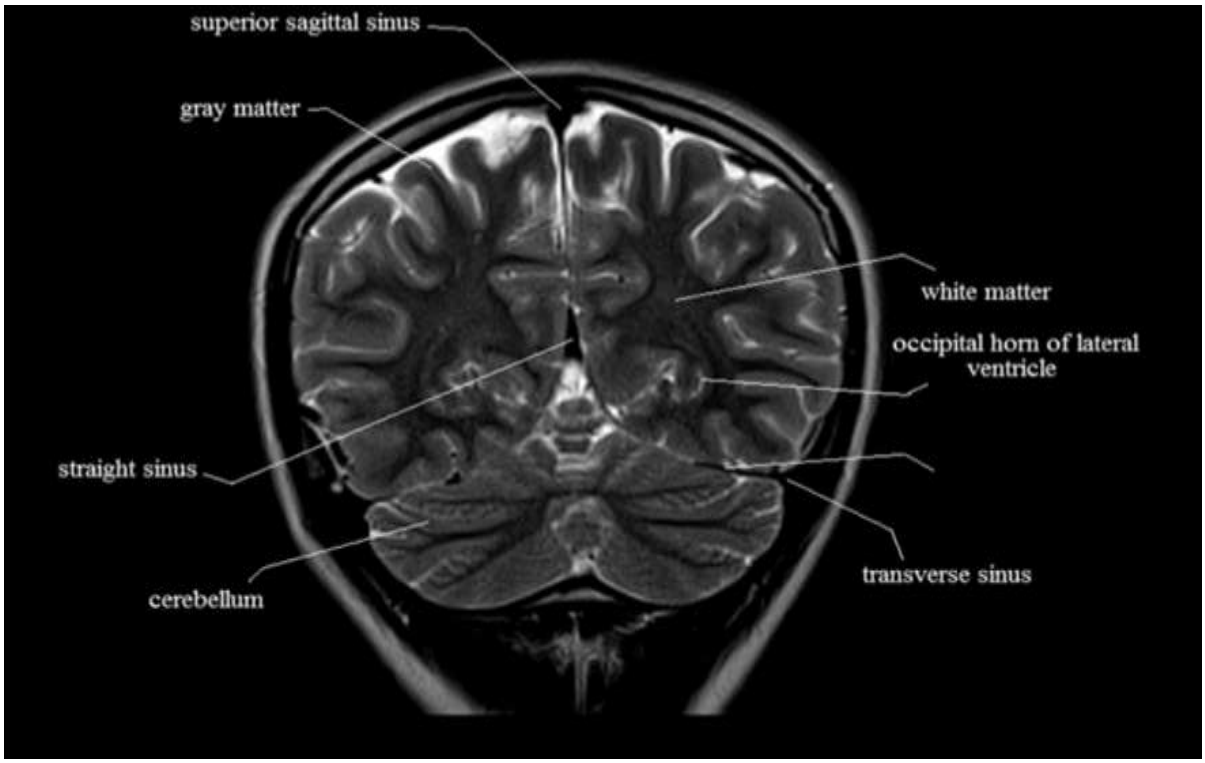
body of caudate nucleus
putamen
globus pallidus
hypothalamus
hippocampus
temporal lobe
body of corpus callosum
body of lateral ventricle
white matter
optic tract
temporal horn of lateral ventricle

(f)

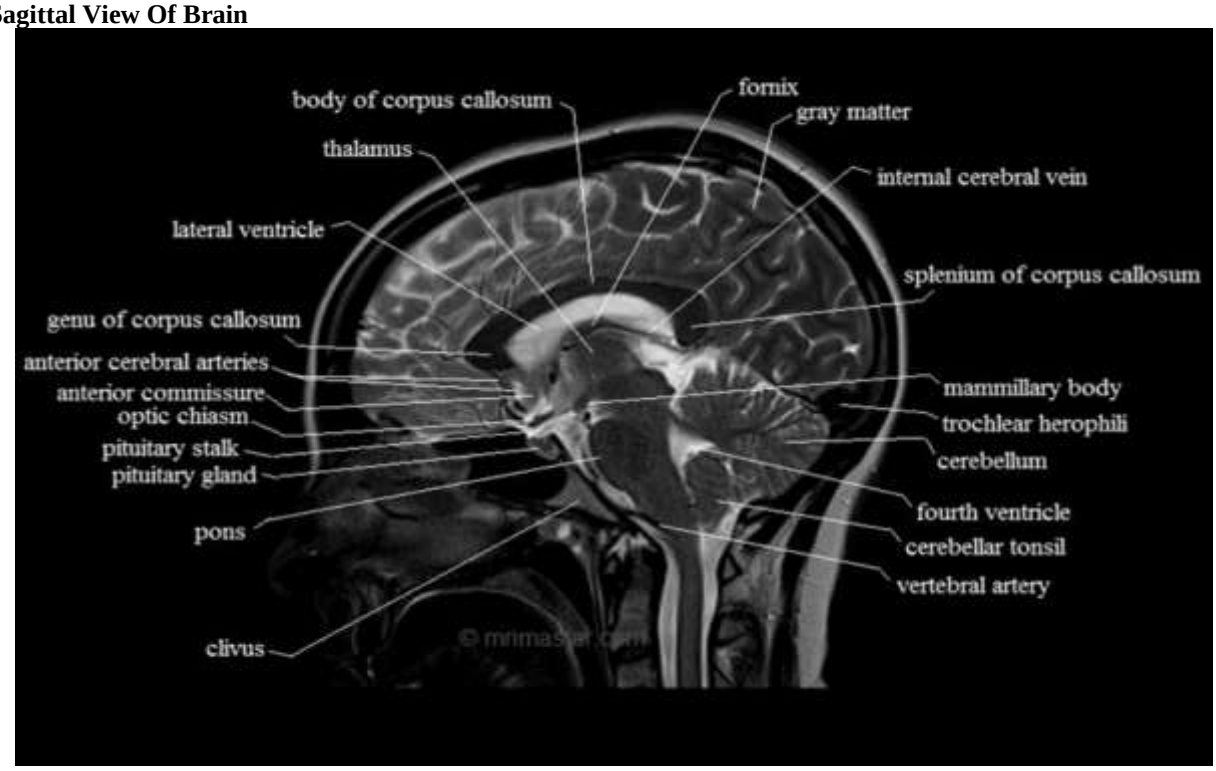

superior sagittal sinus
gray matter
splenium of corpus callosum
white matter
tail of caudate nucleus
atrium of lateral ventricle
internal cerebral vein
tentorium cerebelli
inferior cerebellar vermis
pineal gland
cerebellum
sigmoid sinus
fourth ventricle

(g)


superior sagittal sinus
gray matter
white matter
occipital horn of lateral ventricle
straight sinus
transverse sinus
cerebellum

(h)

Sagittal View Of Brain



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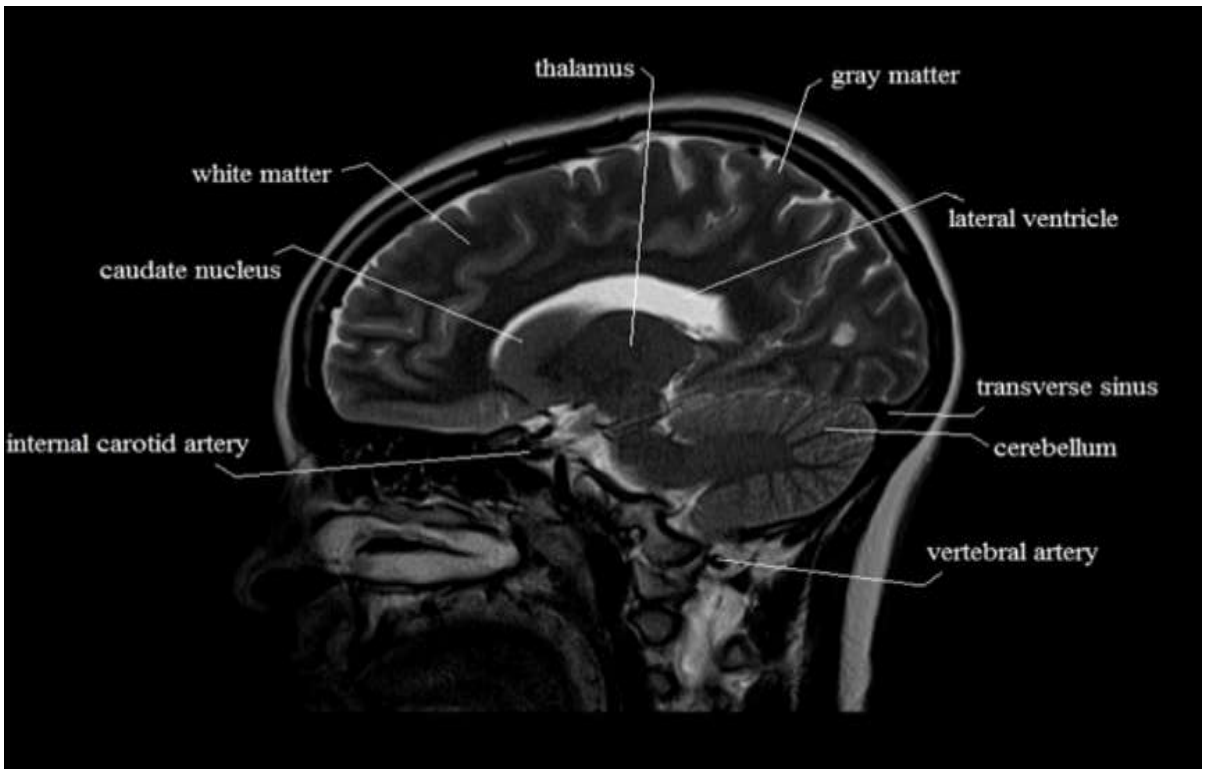

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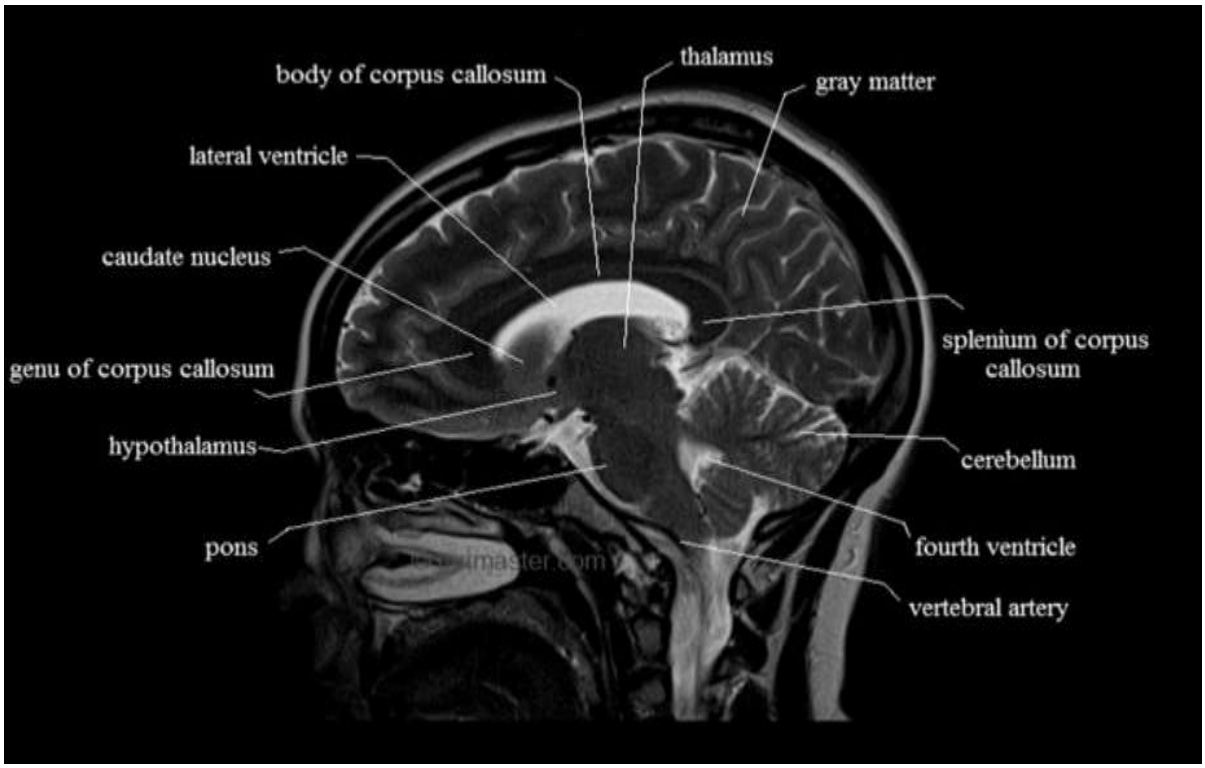
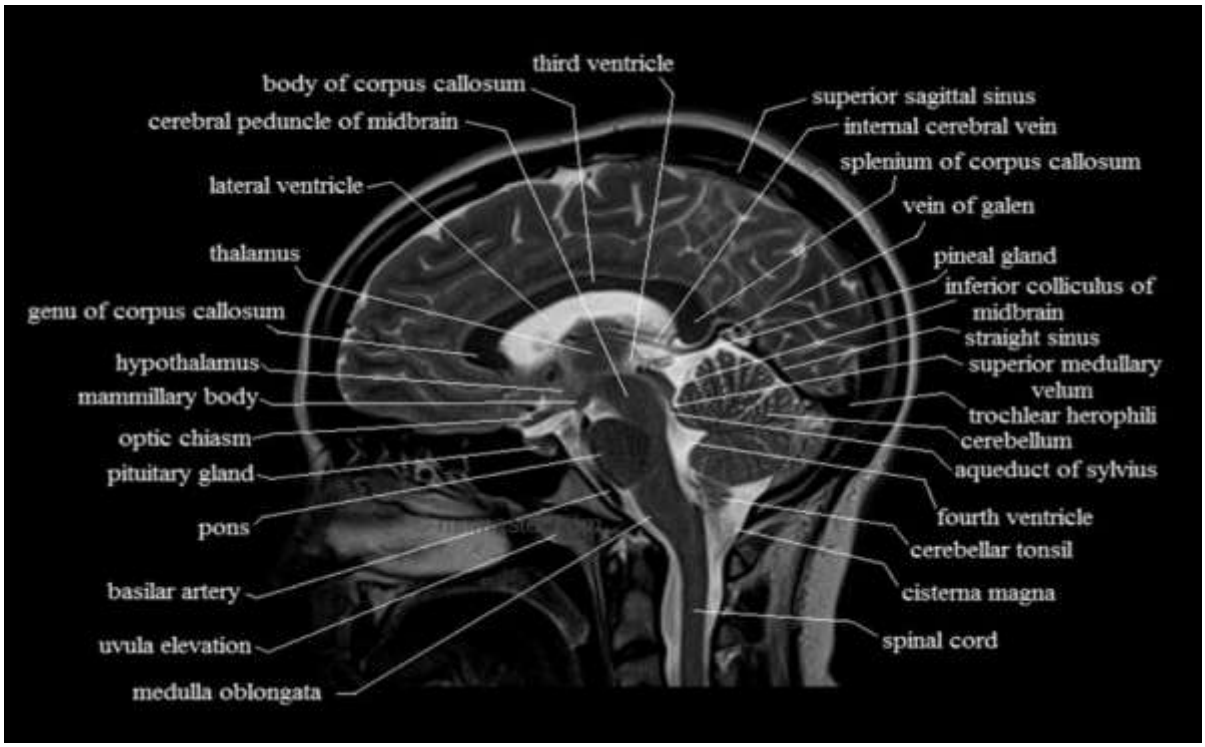
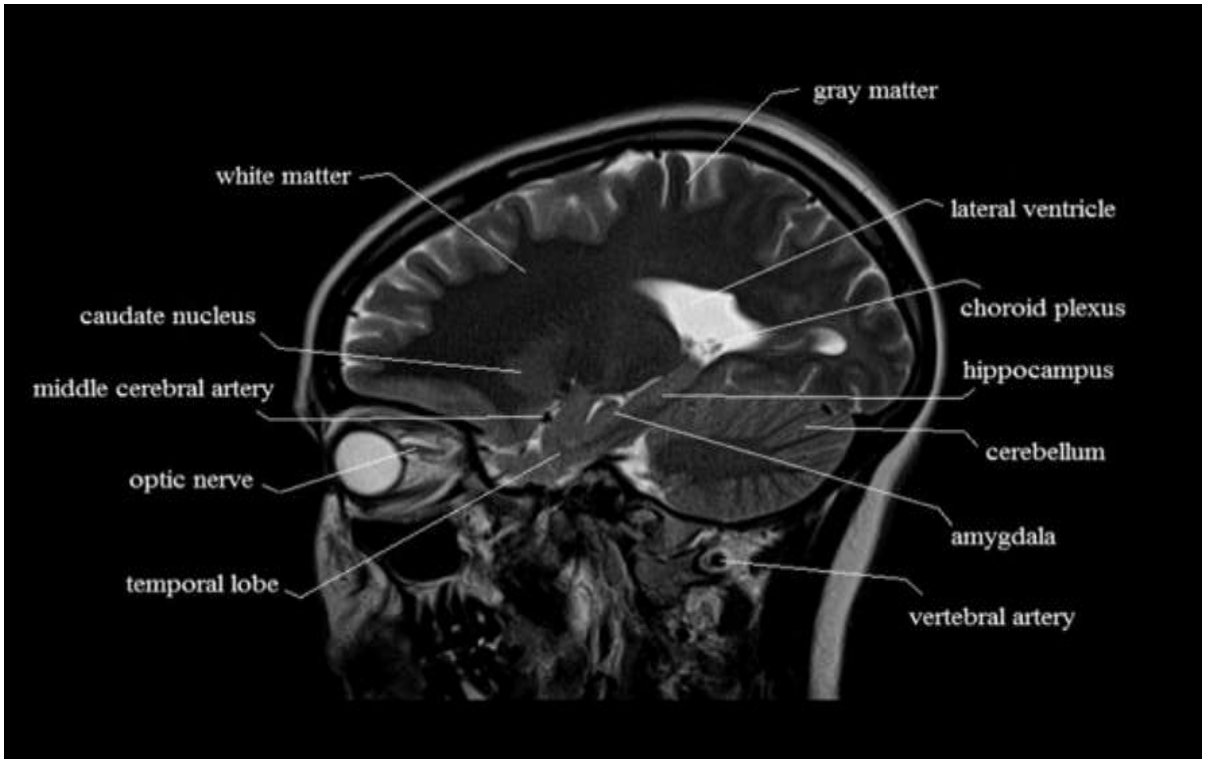

body of corpus callosum
thalamus
gray matter
lateral ventricle
caudate nucleus
splenium of corpus callosum
genu of corpus callosum
hypothalamus
cerebellum
pons
fourth ventricle
vertebral artery

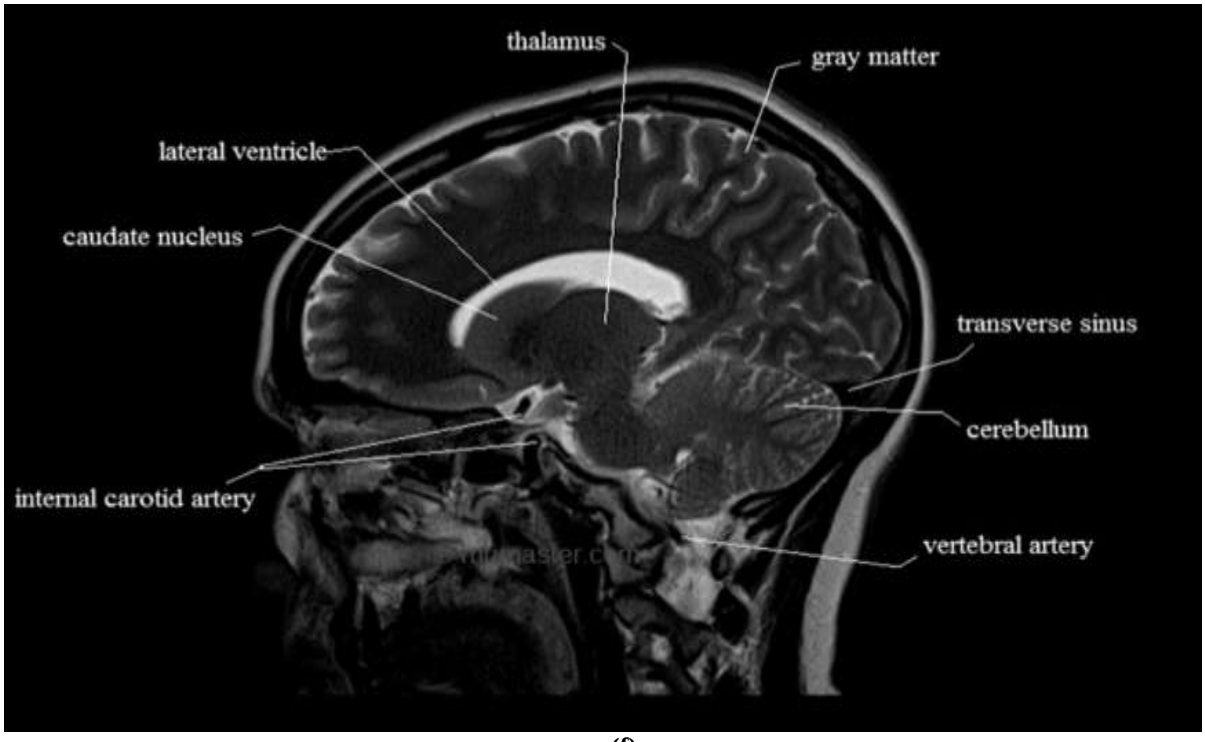
(c)


third ventricle
body of corpus callosum
superior sagittal sinus
cerebral peduncle of midbrain
internal cerebral vein
splenium of corpus callosum
lateral ventricle
vein of galen
thalamus
pineal gland
inferior colliculus of midbrain
genu of corpus callosum
straight sinus
hypothalamus
superior medullary velum
mammillary body
trochlear herophili
optic chiasm
cerebellum
pituitary gland
aqueduct of sylvius
fourth ventricle
pons
cerebellar tonsil
basilar artery
cisterna magna
uvula elevation
spinal cord
medulla oblongata

(d)



(e)



(f)

Study of cerebro vascular accident

Cerebro vascular accident

Cerebrovascular accident is also known as stroke. When the blood flow in the brain is stopped due to the rupture or blockage of blood vessels, it's called as CVA or stroke. There are mainly two types of stroke, which is Ischemic

stroke and hemorrhagic stroke. Ischemic stroke is mainly due to the blood clots or blockage of blood vessels. Hemorrhagic stroke is mainly due to the rupture of blood vessels.[22] These main type of stroke also sub divide in further types, which is shown below;

1. Embolic stroke: Embolic stroke is nothing but similar to thrombolytic stroke where the blood is clot with in the artery but in embolic stroke the clot is formed in other regions apart from brain.
2. Thrombolytic stroke: It occurs when the cerebral arteries are blocked due to blood clots within the brain.
3. Subarachnoid hemorrhagic stroke: It simply refers to its name where the area between the brain and the thin tissues bleeds.
4. Intracerebral hemorrhagic stroke: It's the common type of stroke where the arteries with in the brain ruptures.[15]

Signs and symptoms of stroke:

1. Numbness and weakness on face, leg or arm
2. Vision impairment.
3. Severe headache.
4. Difficulty in speaking and contusion.
5. Difficulty in walking.
6. Dizziness.
7. Loss of balances.

Tests carried out for stroke patients:

1. Computed tomography.
2. Magnetic resonance imaging.
3. CT/MR angiogram.
4. Carotid ultrasound.
5. ECG.
6. Trans cranial Doppler.

Transient Ischemic Attack (TIA):

TIA is also known as Mini stroke. It is a temporary blockage of blood flow towards the brain. Usually TIA is ignored but it's really a major warning from stroke attack. There are some risk factors which cannot be changed for TIA are; family history, age factor, sickle cell diseases, etc. This conditions usually occurs mainly due to the high blood pressure, high cholesterols, cardiovascular diseases, carotid artery diseases, diabetes, peripheral artery diseases, high level homocysteine and excess weight. Even life styles matters in TIA like cigarette smoking, physical inactivity, poor nutrition, heavy drinking and use of illicit drugs. These TIA is a call for preventing future stroke attack which even causes death.

Table of NIHSS (National Institutes of Health Score Scale):

Sr. No	Category	Score 0	Score 1	Score 2	Score 3	Score 4
1A	Level of consciousness	Alert	Drowsy	Stuporous	Coma	--
1B	LOC question: Month & age	Answers both	Answer 1	Both incorrect	--	--
1C	LOC commands: Open/close eyes	Obeys both	Obey 1	Both incorrect	--	--
2	Best gaze	Normal	Partial gaze	Forced deviation	--	--
3	Visual	No visual loss	Partial loss	Complete hemianopsia	Bilateral hemianopsia	--
4	Facial palsy	Normal	Minor	Partial	Complete	--
5A	Motor arm - left	No drift	Drift	Can't resist gravity	No effort gravity	No movement
5B	Motor arm – right	No drift	Drift	Can't resist gravity	No effort gravity	No movement
6A	Motor leg – left	No drift	Drift	Can't resist gravity	No effort gravity	No movement

6B	Motor leg – right	No drift	Drift	Can't resist gravity	No effort gravity	No movement
7	Limb ataxia	Absent	Present in 1 limb	Present in both limb	--	--
8	Sensory	Normal	Partial loss	Severe loss	--	--
9	Language	No aphasia	Mild - moderate	Severe	Mute	--
10	Dysarthria	Normal	Mild - moderate	Severe	--	--
11	Inattention & extinction	No neglect	Partial neglect	Complete neglect	--	--

These Scores are used to identify the growth of stroke in each individual. When the score of NIHSS is 0, it is consider to be a normal individual without any stroke. Whereas the scores from 1-42 indicates the level of stroke present in them and makes the physician easier to assess the patient accordingly.[4] The level of NIHSS score is mentioned below:

Table for Score of NHISS:

Score of NHISS	Stroke severity
0	No stroke
1-4	Minor stroke
5-15	Moderate stroke
16-20	Moderate – severe stroke
21-42	Severe stroke

There is another scoring system used in diagnosis of stroke which is named as "Alberta Stroke Programme Early Computed Tomography Score" also known as ASPECTS. These ASPECTS are Segmental assessment of the middle cerebral artery. vascular territory and one point minuses from the initial score of 10 for every region involved for scores.[25] The score reading and the table of ASPECTS is mentioned below:

Table for score of ASPECTS:

Score of ASPECTS	Stroke severity
0-5	Large core
6-7	Moderate core
8-10	Small core

Table of list of ASPECTS (Alberta Stroke Programme Early Computed Tomography Score):

Sr. No	List of ASPECTS Scores
1.	Caudate
2.	Putamen
3.	Internal capsule
4.	Internal cortex
5.	M1: Anterior MCA cortex
6.	M2: MCA cortex lateral to insular ribbon
7.	M3: Posterior MCA cortex

8.	M4: Anterior MCA superior territory
9.	M5: Lateral MCA superior territory
10.	M6: Posterior MCA superior territory

Sequences Used In Stroke Cases
Protocols For Stroke

There are various sequences used in MRI while scanning the image of particular organs. But in this thesis we mainly focuses on the Protocols of CVA patients, i.e. the sequences which are mainly used to view the images of stroke patient. The commonly used MRI protocols are listed below:

1. Localizer
2. Shimming & Mapping
3. T1 axial
4. T2 axial
5. T2 sagittal
6. FLAIR axial
7. GRE axial
8. DWI.

Localizer:

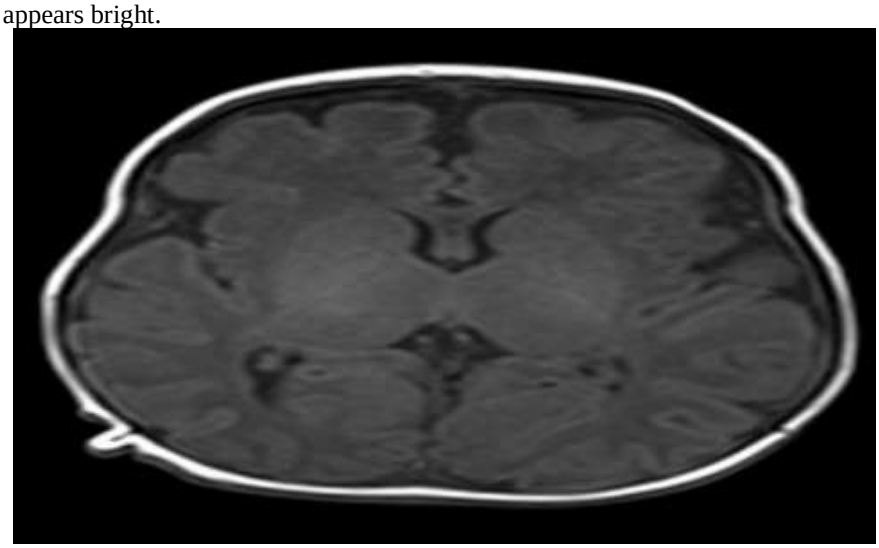
It is nothing but the set of 3 planes i.e. axial, coronal and sagittal planes are scout viewed with low resolution and with large field of view.

Shimming & Mapping:

It is a process where the magnetic area is made homogenous, as we do warm up in CT so as to reduce the inhomogeneities of magnetic area we do shimming in MRI.

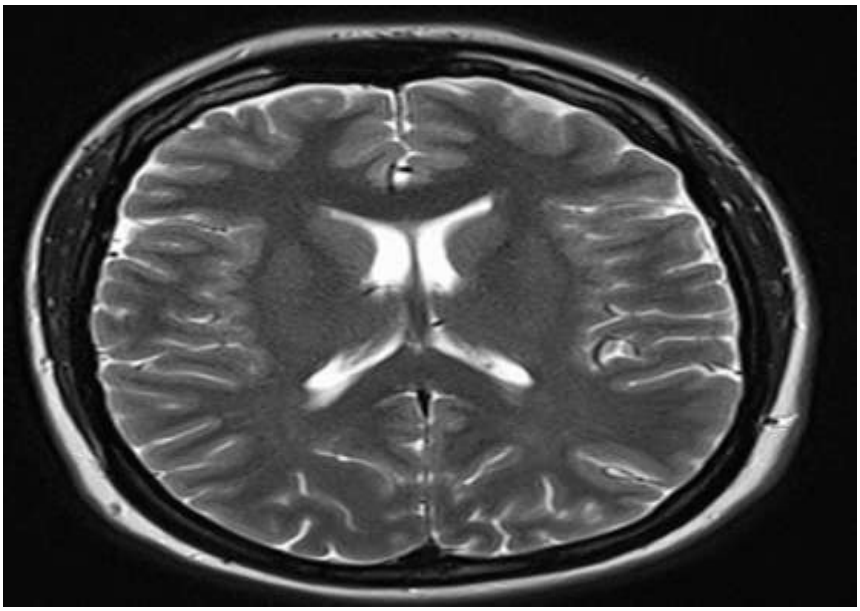
T1 axial:

When the patient is asked to lie in the MRI scanner table, the hydrogen molecules of the body lines up along the magnetic field. The radiofrequency pulse causes the atoms to flip into another direction when they are turned on and these atoms relax back when the RF pulses are turned off. These process is known as relaxation. These relaxations are mainly T1 (longitudinal relaxation time) and T2 (transverse relaxation time). The human organ images are visualized only by this two relaxation methods. When the image is described as T1 weighted image that means the main source of contrast is T1. T1 axial images are nothing but the T1 weighted images. Basic method to remember how T1 images look is the Fluid levels in T1 weighted images appears dark and air and bone also appears dark where as the fats appears bright.



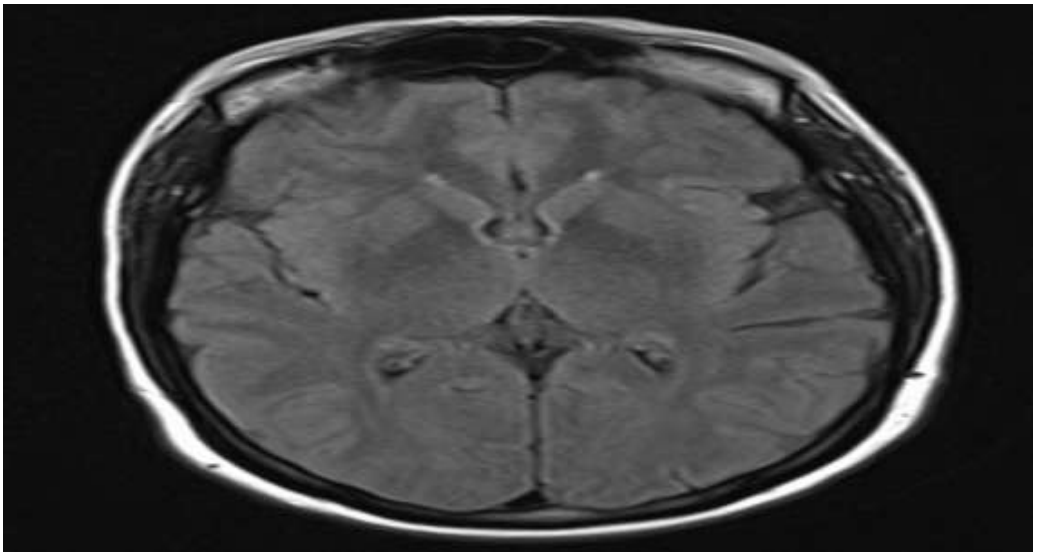
T1 Axial

T2 axial:
T2 weighted images are the main source of contrast in T2. T2 axial images are nothing but the T2 weighted images. T2 image appears brighter than T1 image which is easily accessible for the radiologist to diagnose the case, In T2 axial images Fluid levels appears bright.



T2 Axial

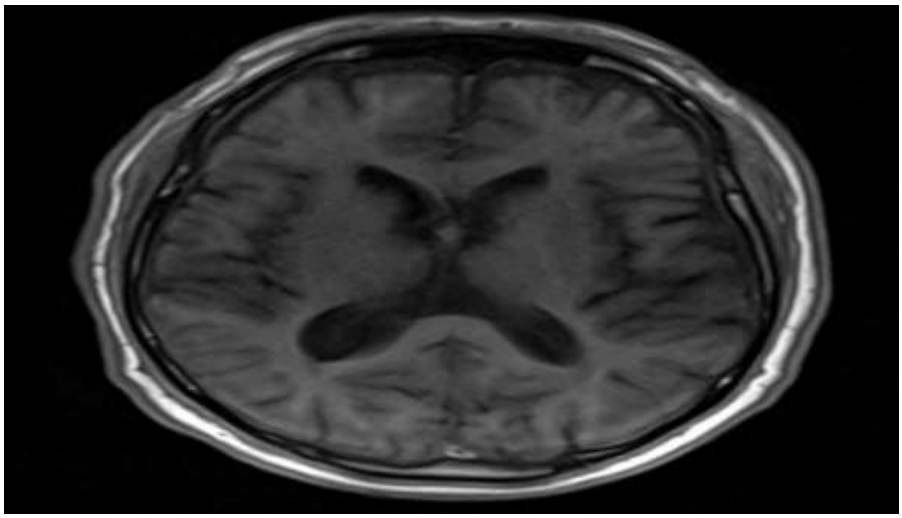
1. T2 sagittal: T2 weighted images are the main source of contrast in T2. T2 sagittal images are nothing but the T2 weighted images in lateral form. Images appears bright compared to T1 especially fluids.
2. FLAIR axial: FLAIR also known as Fluid Attenuated Inversion Recovery, which comes under the Inversion recovery sequences. The IR sequence is the spin echo sequences with 180 degree plane pulse to flip the longitudinal magnetization into opposite direction. In FLAIR the fluid especially CSF is suppressed in order to see the lesions in brain and spinal cord. FLAIR images also appears bright.[9]



FLAIR Axial

GRE Axial:

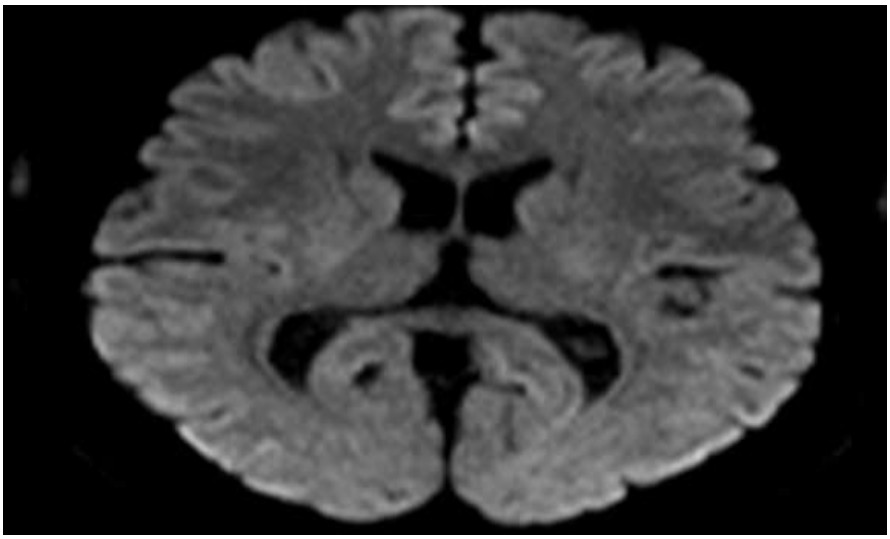
Gradient Echo (GRE) sequence is also known as Fast Low Angle Shot (FLASH) where it uses the radio frequency excitation pulses with low flip angle which is less than 90 degrees. The simplest way to identify the GRE images is that the fluid appears dark and it has a low SNR.



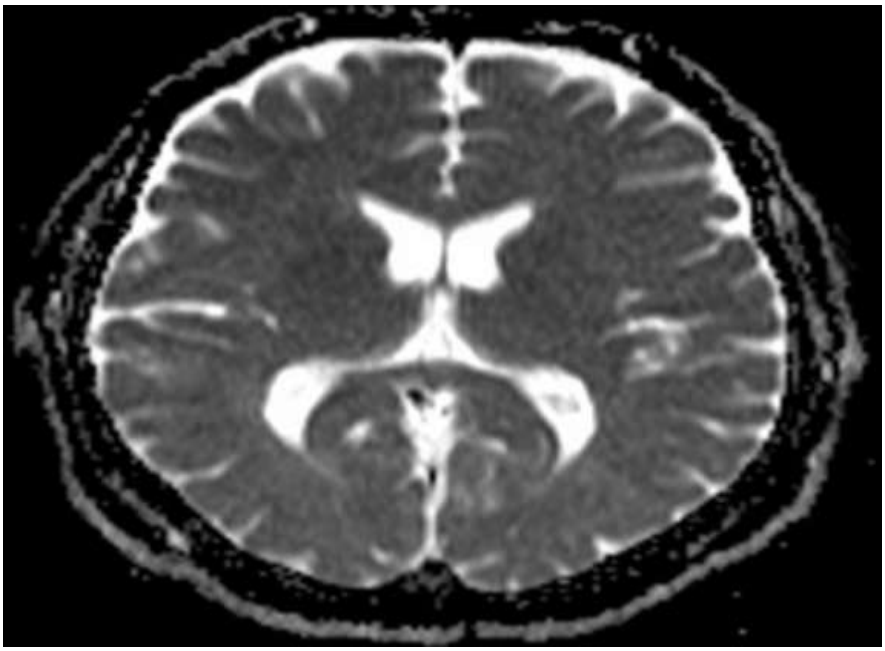
Gradient Echo Axial

DWI Axial:

DWI is also known as Diffusion-weighted Image. This magnetic resonance imaging uses a T2-weighted pulse sequence with 2 extra gradient pulses which is equal in magnitude and opposite in path. These gradient pulses are than applied in between the nuclear spin and data acquisition. Therefore, imaging is more sensitive to water molecular motion in the path of the additionally applied gradients. These extra gradient pulses lead to an attenuation of the signal intensity along the axis to which they are applied which is proportional to water diffusion in the area. How much the water diffusion is higher that will result in good signal attenuation and appears darker on images. Hence, these areas appear hyperintense or bright on DWI. The magnitude of signal attenuation in water on DWI depends on two factors i.e. the translational movements of water molecules, and the amount of diffusion weighting. The sensitivity of DWI is measured by 'b' factors. The higher values of 'b' will have the better sensitivity of DWI. (b50, b500, b1000 & b1400). Apart from the DWI data, there is another way to present diffusion data which is called the Apparent Diffusion Coefficient (ADC) map of water. These are considered or measured from DWI after the acquisition. DWI plays a important role in analysis of stroke. DWI is sensitive for early stroke diagnosis. It also helps to identify whether the infract is acute or chronic.[6]



DWI (b1000)

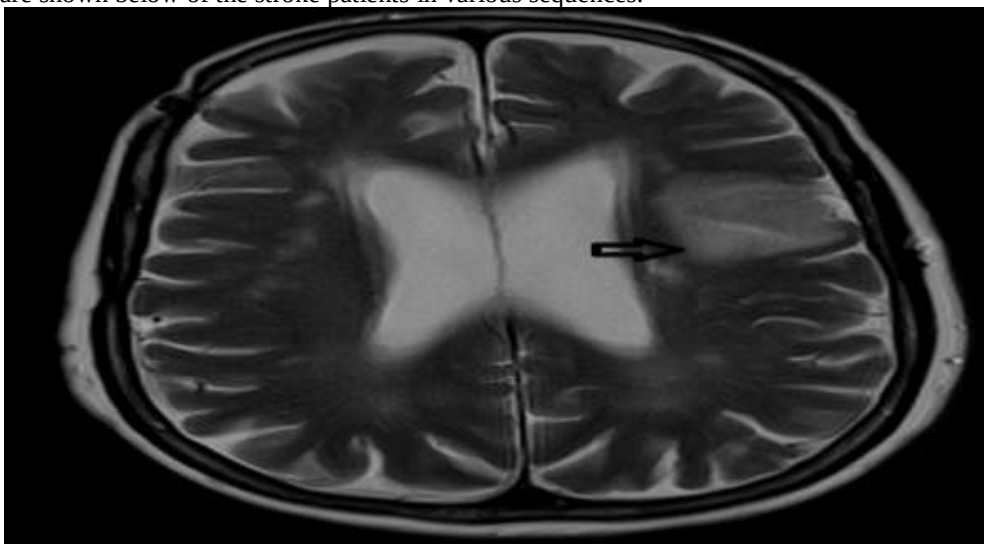


DWI (ADC)

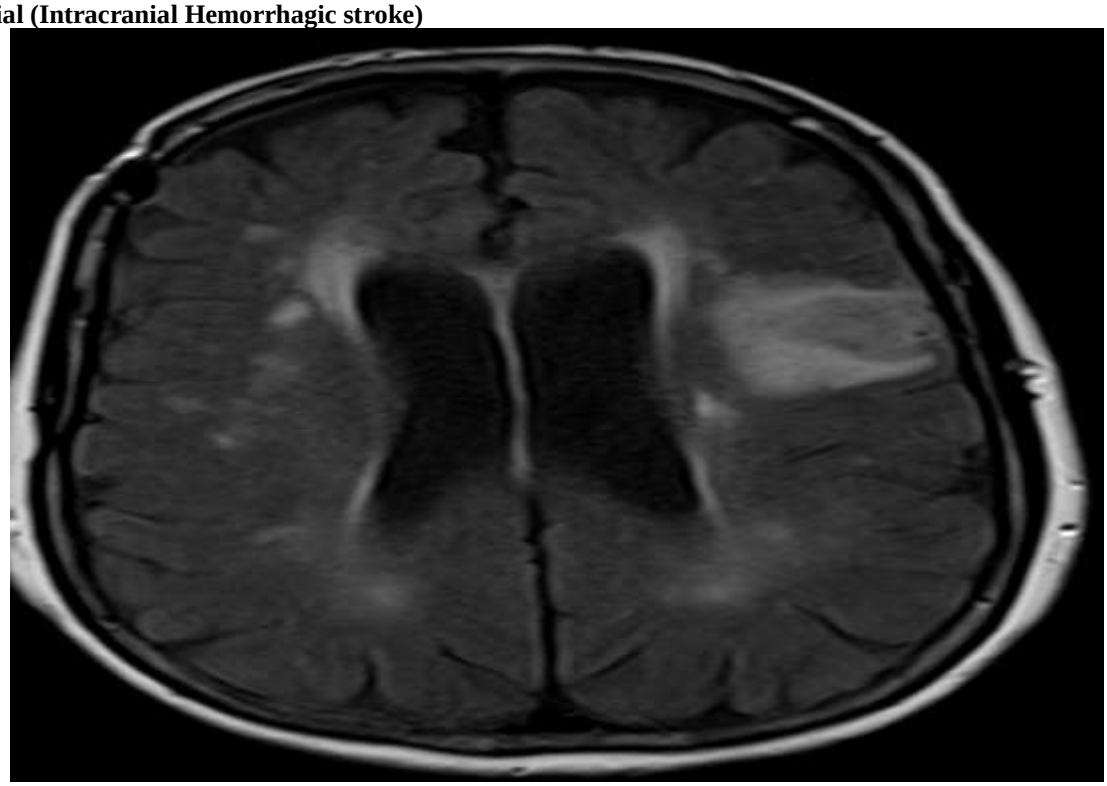
The parameters used in my research work is as listed below in tabular form:

Sequence	TR	TE	Slice	Flip	Matric	FOV	Gap	Nex
T1 cor	400-600	15-25	5mm	90	320X320	210	10%	2
T2 axial	3000-4000	100-120	5mm	130-150	320X320	210	10%	2
FLAIR axial	7000-9000	110	5mm	130	320X320	210	10%	2
T2 sag	3000-4000	100-120	5mm	130-150	320X320	210	10%	2
DWI (b1000)	7000-9000	110	5mm	130-150	192X192	210	1%	4

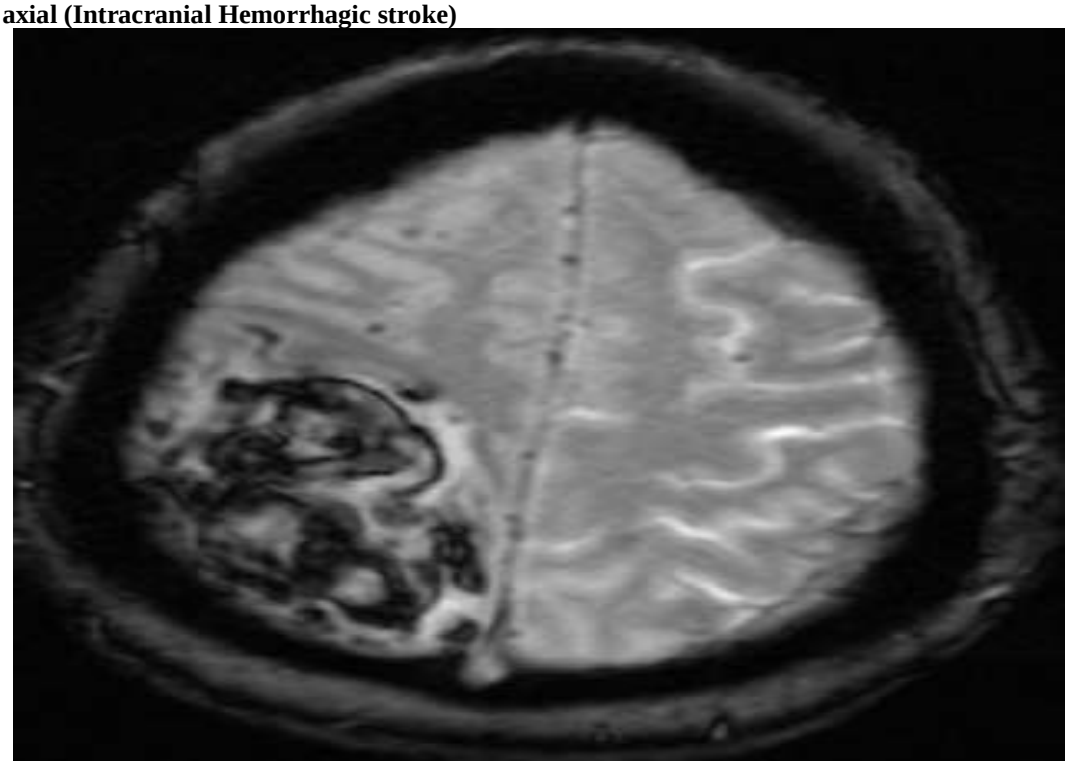
The Images are shown below of the stroke patients in various sequences:



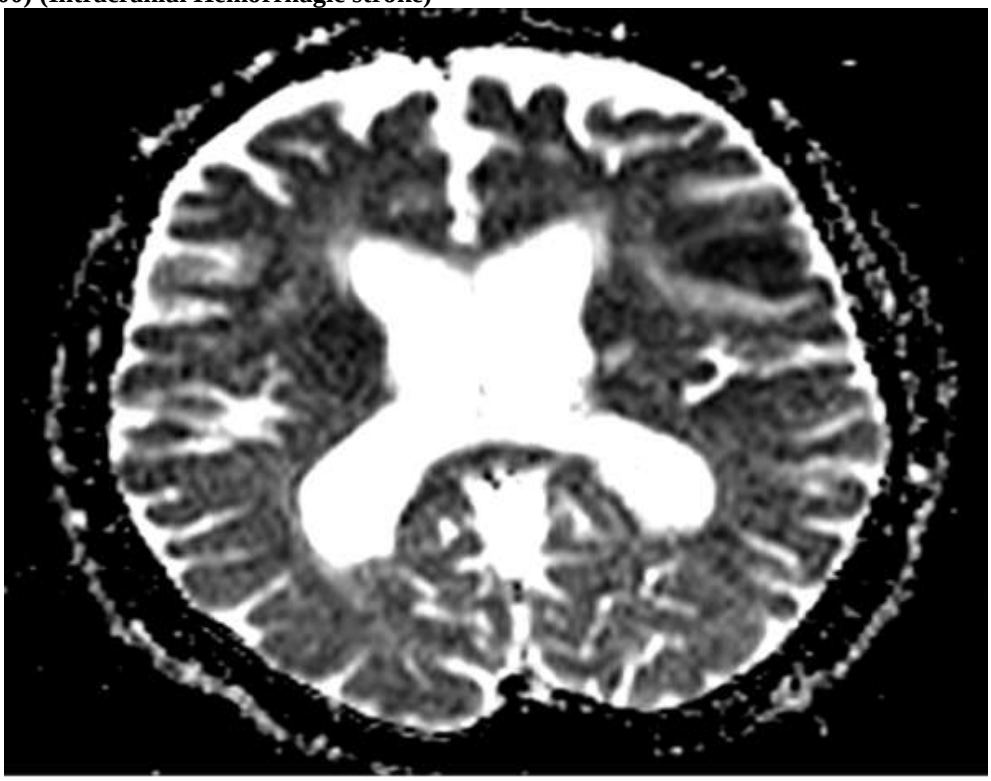
T2 axial (Intracranial Hemorrhagic stroke)

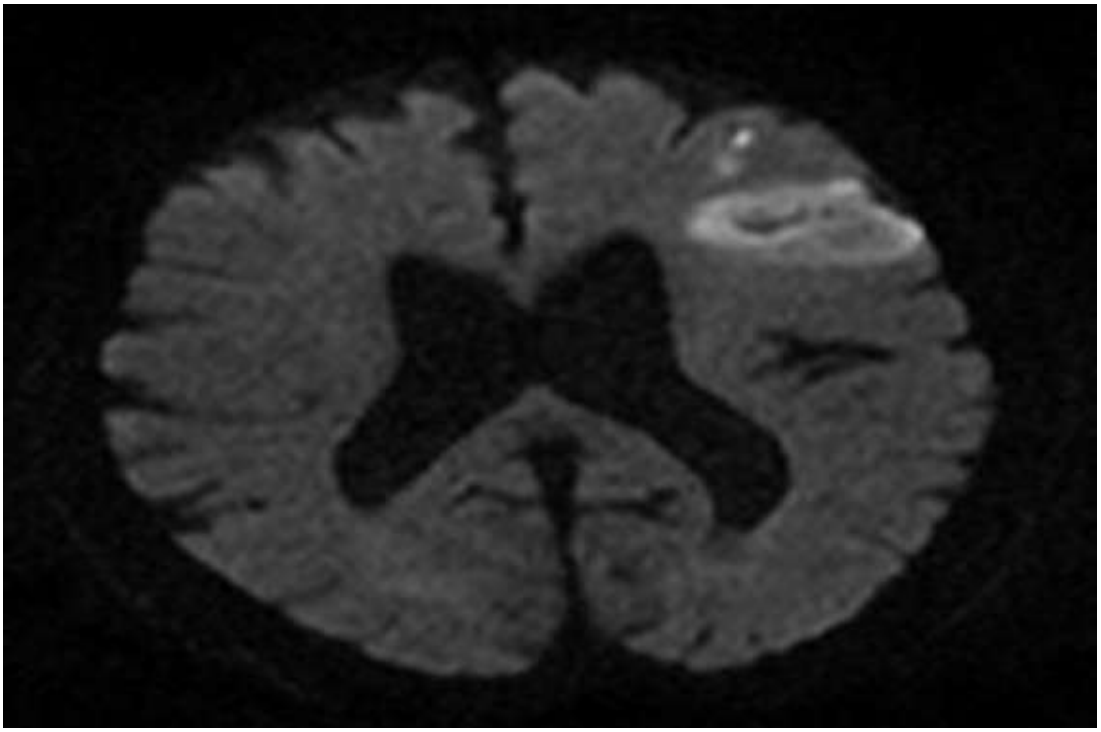


FLAIR axial (Intracranial Hemorrhagic stroke)

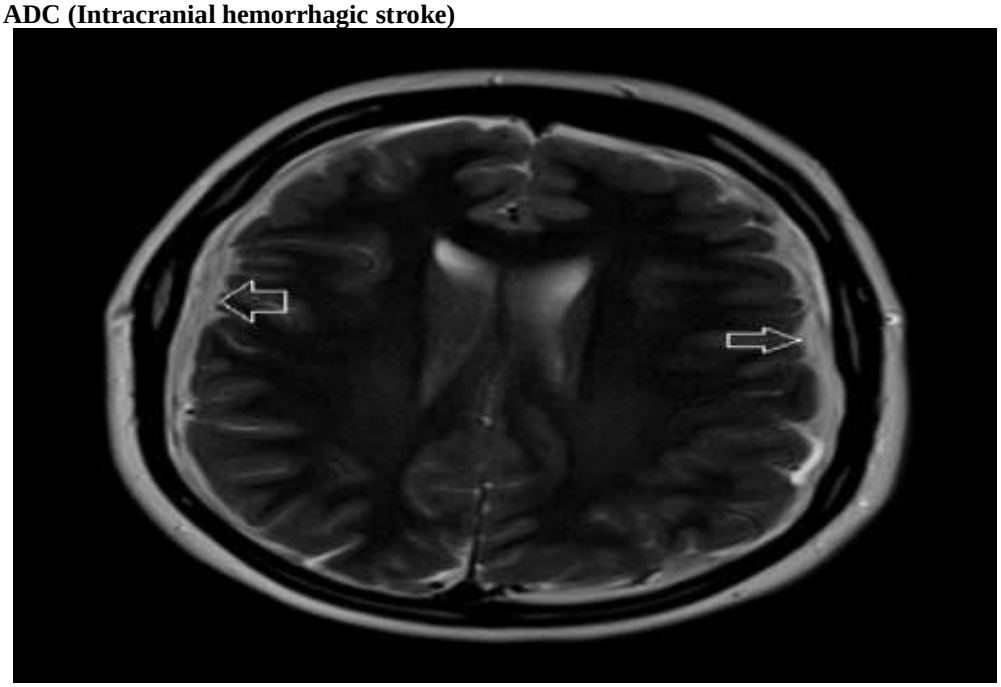


GRE axial (Hemorrhagic stroke)
DWI axial (b1000) (Intracranial Hemorrhagic stroke)

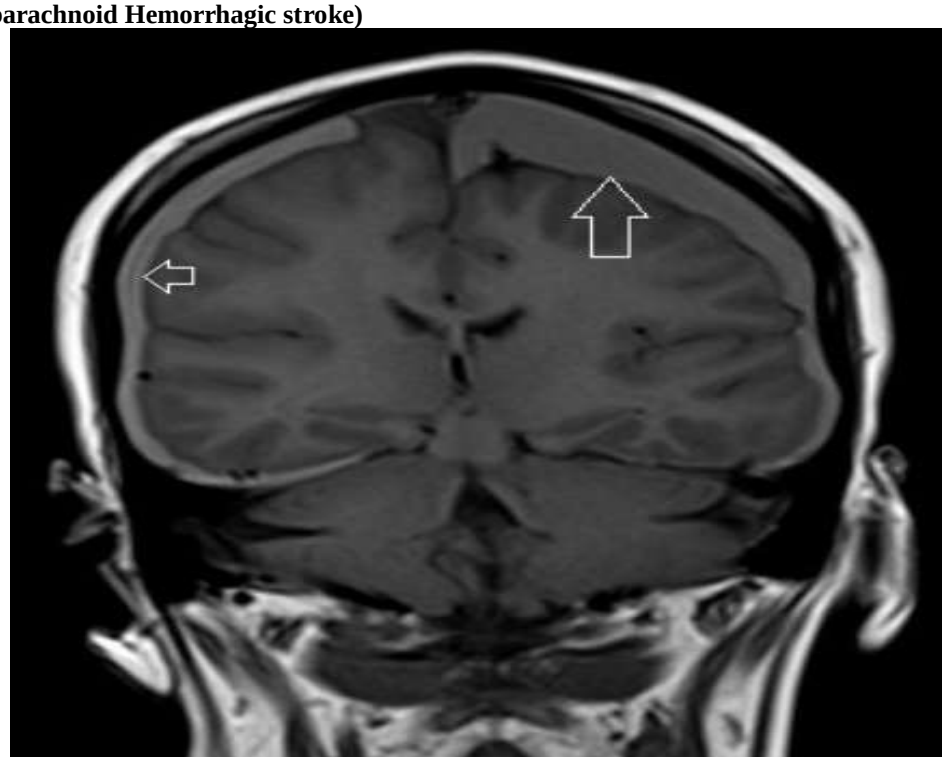




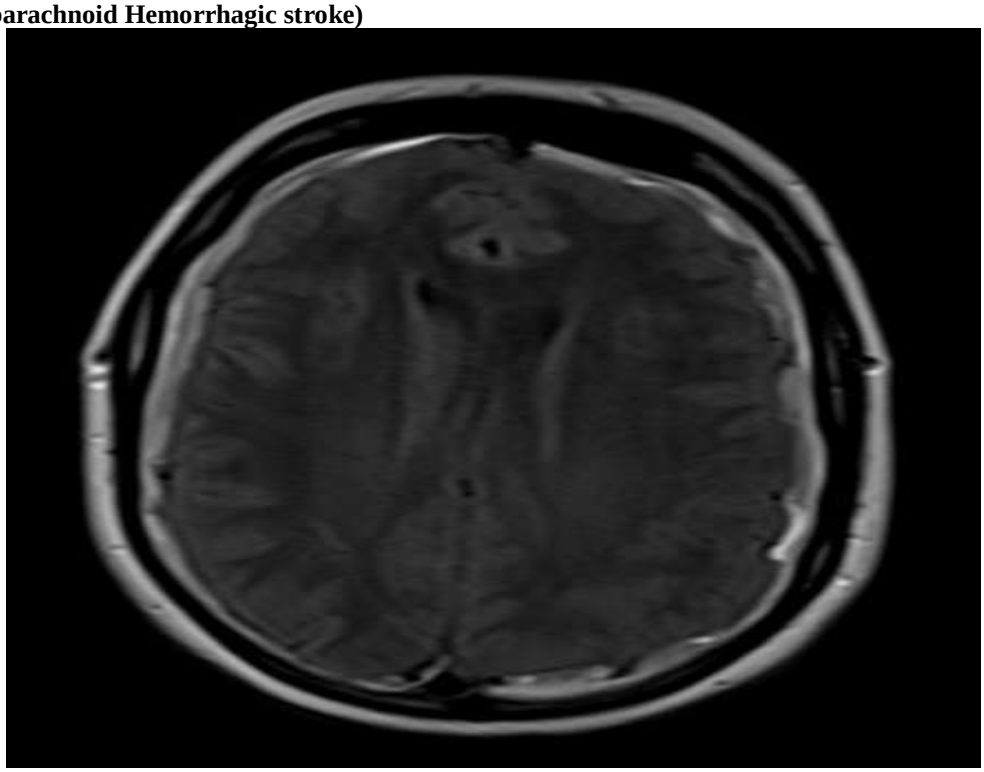
DWI axial ADC (Intracranial hemorrhagic stroke)



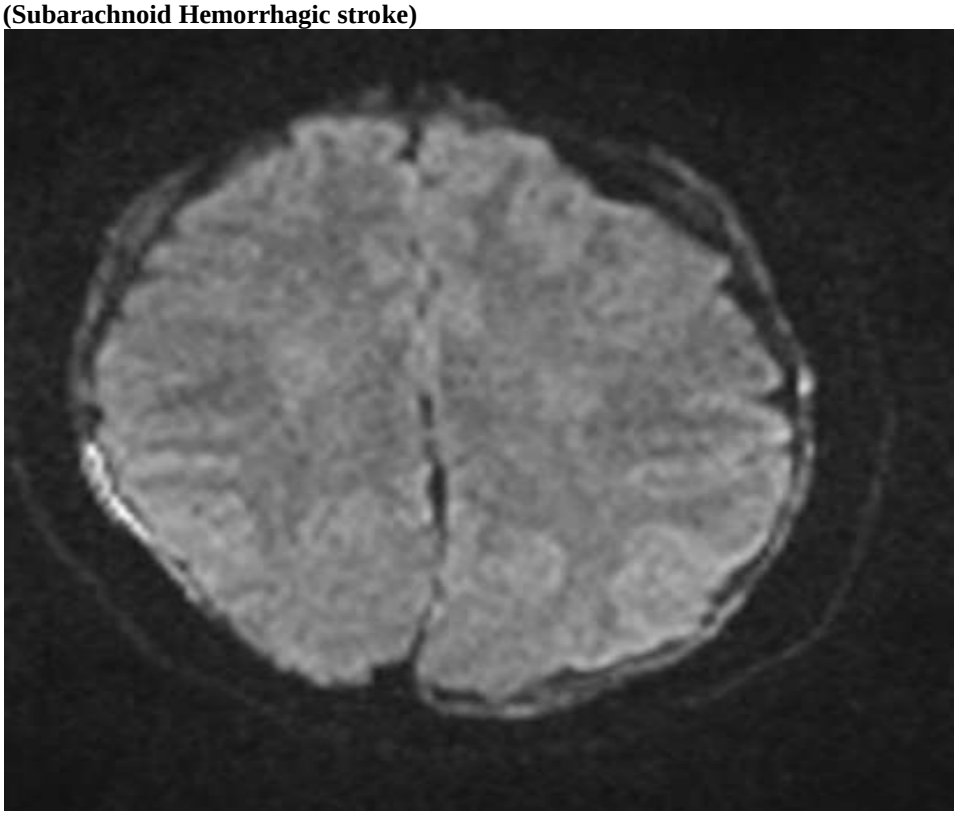
T2 axial (Subarachnoid Hemorrhagic stroke)



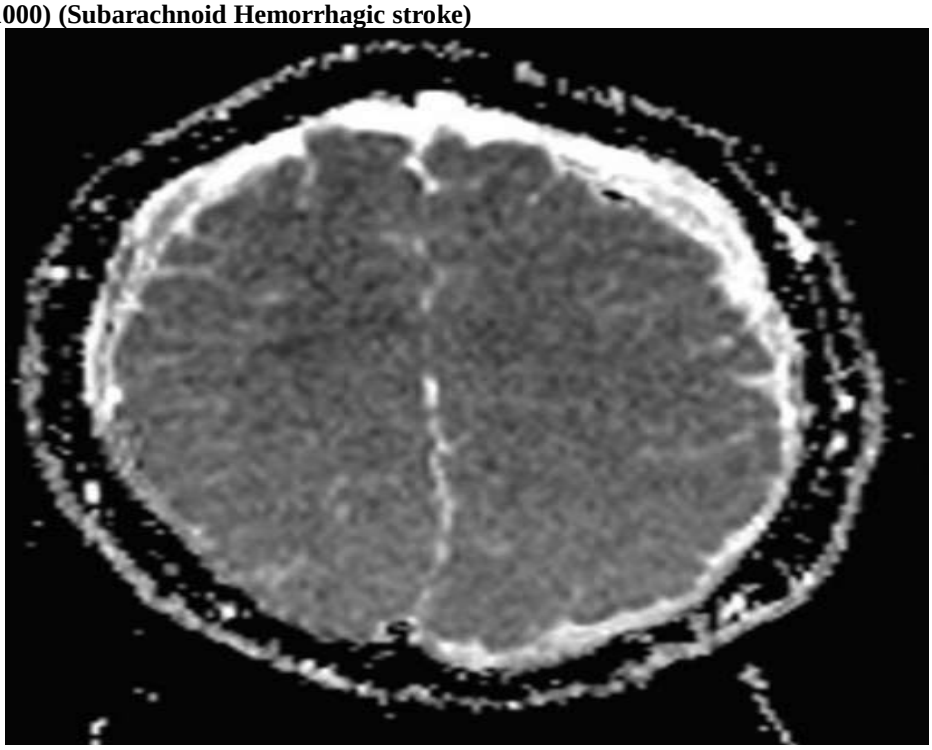
T1 cor (Subarachnoid Hemorrhagic stroke)



FLAIR axial (Subarachnoid Hemorrhagic stroke)

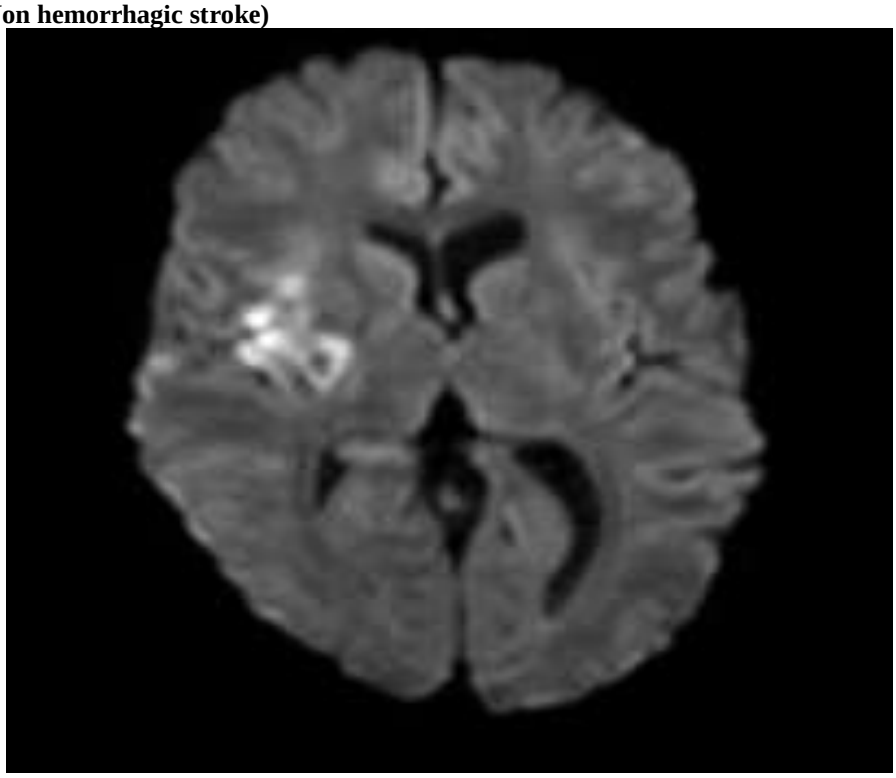


DWI axial (b1000) (Subarachnoid Hemorrhagic stroke)

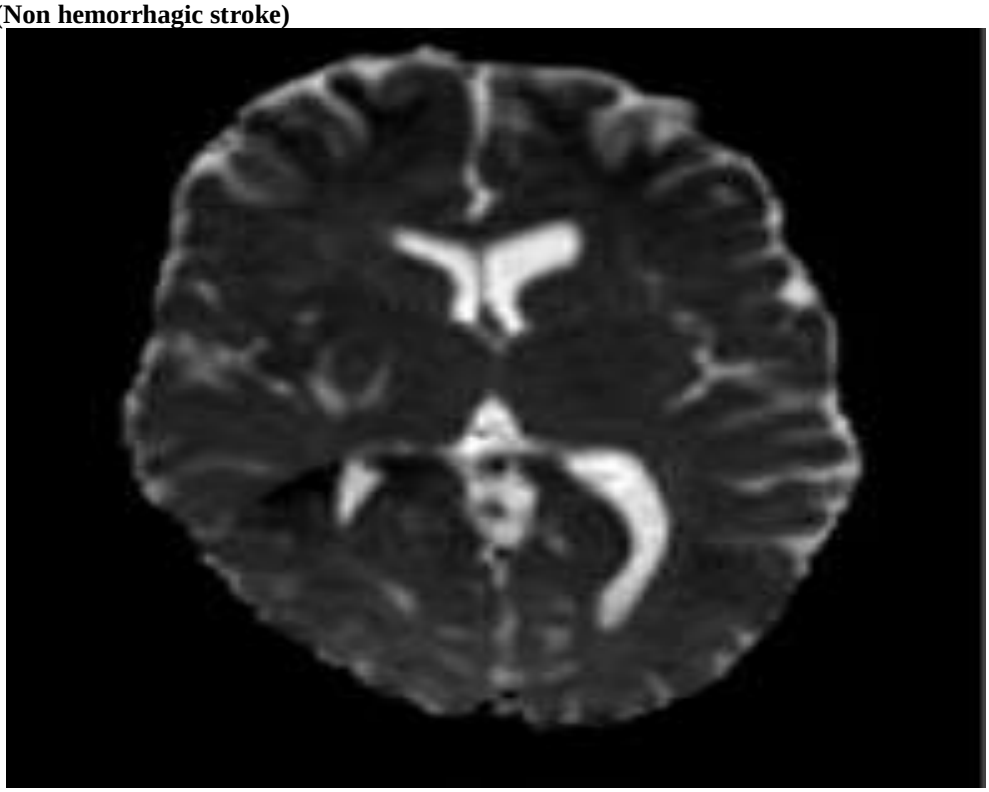


DWI axial ADC (Subarachnoid Hemorrhagic stroke)

FLAIR axial (Non hemorrhagic stroke)



DWI axial (Non hemorrhagic stroke)



DWI axial ADC (Non hemorrhagic stroke)

Results:-

I have completed my research work during the period of 8 months, where I was given to collect about 50 patients with CVA condition and compare with the MRI sequences used for each patient and to identify which sequence is most commonly used and best sequence to identify the stroke in the human brain. During my research of 50 patients, 32 where male and 18 where female patients.

Pie chart for Age group:

0-20Y=6%
21-40Y=18%
41-60Y=35%
60Y & above=44%

Pie chart of Gender:

Male =64%
Female=36%

The pie chart above describes the percentage of people getting affected with stroke within a period of 8 months, where maximum of old age people are prone to get stroke. In this survey males are more in ratio compared to females affected with CVA disorder. After collecting the data it was observed that the ischemic stroke ratio is more compared to the hemorrhagic stroke and most commonly acute condition observed. The ratio of the following data is listed below in form of pie chart.

Pie chart on the infarct of lesions:

According with this research, it was found that the most important sequence used for evaluation of cerebral vascular accident patients is Diffusion weighted images sequence, where it helps the radiologist to identify the whether the stroke is acute i.e. the recent stroke or whether it is the chronic a long term stroke. DWI also identifies early stroke as result. The below graph represents the percentage of how much the sequences are involved in identifying the stroke level.

Bar diagram of % indication for sequences used in stroke evaluation:

Y-axis

X-axis

T1 axial: 10%
T2 axial: 40%
FLAIR: 60%
GRE: 40%
DWI: 80%

The Imaging finding of each stages of stroke in MRI is listed below in tabular format:

STAGES OF STROKE	T1 Weighted Image	T2 Weighted Image & FLAIR	DWI	ADC
Hyper acute (<24hr)	Isointense	Isointense or hyper intense	High signal intensity	Low signal intensity
Acute (1-3days)	Hypo intense	hyper intense	High signal intensity	Low signal intensity
Early subacute (3-7days)	Hypo intense	hyper intense	High signal intensity	Low signal intensity
Late subacute (7-30days)	Hypo intense	hyper intense	High signal intensity	High signal intensity later
Chronic (>1 month)	Hypo intense	Hypo intense with surrounding hyper intensity	Normalized	Normalized

Discussion:-

While focusing on the study of CVA case it was revealed that the diffusion weighted images play most important role in identification of stroke compared to any other sequences. We discussed in detail about each and every sequences of MRI which helped in evaluation of stroke cases, each and every protocols are essential in identifying the disorder in some or the other way. It also reveals how old the infract is, like acute or chronic.

We also understood how MRI is more effective than CT studies. MRI helps to learn in depth about each and every organs and tissues with the blood vessels and provides information through digital images and are also very harmless to human body, where the CT is harmful due to radiation and provides also basic organ information.

CT is helpful in ruling out hemorrhagic stroke as opposed to non-hemorrhagic stroke where the line of management of the case changes as in non-hemorrhagic stroke the patient can be subjected to intravenous or intra-arterial thrombolysis as well as mechanic-chemical thrombectomy in Interventional radiology. This can be evaluated quickly and more accurately in CT as compared to MRI.

MRI is helpful in giving soft tissue detail and timing of the stroke. In my study Diffusion and ADC sequence have been found to be more sensitive (%) and specific (%) for detection of stroke in the Hyperacute and Acute stages. FLAIR sequence is helpful in identifying Chronic stroke and also in ruling out minimal hemorrhage in chronic stage which could not be picked up on plain CT

Hence according to the time of presentation of stroke the type of protocol in CT or MRI has to be modified:

Sr no	Timing of stroke	Protocol to be used
1	Hyperacute and Acute cases	(DWI , ADC MRI sequence) + (Non Contrast CT)
2	Chronic cases	FLAIR and GRE sequence

In MGM Hospital, whenever a stroke patients comes, the department gives priority and provides all necessary supplements for the patient safety. All the necessary paper works are done by the relatives or guardians and the patient is taken inside the scan room without any delay. It was observed that in emergency cases the radiologist also helps the technician for the scan purpose and carry out the study by controlling the time limit as less as possible with the best quality of images required.

Conclusion:-

CT is helpful in ruling out hemorrhagic stroke as opposed to non-hemorrhagic stroke where the line of management of the case changes as in non-hemorrhagic stroke the patient can be subjected to intravenous or intra-arterial thrombolysis as well as mechanic-chemical thrombectomy in Interventional radiology. This can be evaluated quickly and more accurately in CT as compared to MRI.

MRI is helpful in giving soft tissue detail and timing of the stroke. In my study Diffusion and ADC sequence have been found to be more sensitive (%) and specific (%) for detection of stroke in the Hyperacute and Acute stages. FLAIR sequence is helpful in identifying Chronic stroke and also in ruling out minimal hemorrhage in chronic stage which could not be picked up on plain CT

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The most important sequence used for evaluation of cerebral vascular accident patients is Diffusion weighted images sequence, where it helps the radiologist to identify the whether the stroke is acute i.e. the recent stroke or whether it is the chronic a long term stroke.

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