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IMAGING PROTOCOLS AND PATIENTS POSITIONING IN MAGNETIC RESONANCE IMAGING OF BRAIN EXAMINATION

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Abstract— **MRI brain exam is one of the most common cases for outpatients as well as inpatients visits to find out various brain diseases. The topic helps the radiographer regarding the patient preparation and protocols are optimized for patient care and well standard. A retrospective cross sectional study was conducted receiving 50 patients report and request that had MRI brain scan period of six months from October 2019 to March 2020.The information obtained was recorded on a self designed data capture sheet data was analyzed using Microsoft excel 2007 and descriptive statistics. A total of 50 MRI brain examination were reviewed, consisting of 34 males and 26 females. Their age range is from 10-70 years. The table show the age distribution of patients. The most common and affected age groups in males are51-60 and in females 41-60 years respectively. And out of 50 patients examination reviewed Neurology are the most referred department to patients for examination of MRI brain. The imaging protocols and patients preparation illustrates general principles that are applicable. Each user, however, has specific needs preferences, and categories of patient pathology as well as age group, and may be constrained by available hardware and software in both machine and computer. Each imaging protocol should be the right mix of speed, resolution and image quality, but because of specific user specific variables. It is a difficult to recommended a standard set of protocols. A solution of that work effectively at our institution will the establishment of a regular protocol meeting and discuss composed of radiology staff, including MRI technologists and MRI physicists. Modified a new protocol is review, discuss and implemented.**

Keywords— **TR, TE, TI, ADC, CEMRA, LM, FOV, SNR, SE, GRE, PD, Rf, NM, SNR, Hz, MHz, CSF, MRA, FLAIR, DWI, FSE, Gd, EP, STIR, T1W, T2W, mMRI, CT HASTE**

I. INTRODUCTION

Magnetic Resonance Imaging of brain is one of the radiological examination with non invasive which provide the cross sectional image of the brain anatomy and physiology as thin slice with a radio frequency range 1-80 MHz. The image are formed by the body are placed under the strong magnetic field and the magnetic field align inside the body proton uniformly. The radio frequency coil which serves the receiver and transmitter send the signal to the computer for the signal are processed and mathematically reconstructed then image can visualize coronal sagittal and transverse section on computer monitor. The new technological and advancement improvement in computer provide the image can be visualize with three dimensional pictures and spectroscopy for the study of metabolism. Magnetic Resonance Imaging of brain are classified as contrast Gadolinium with injection of contrast dye through veins and arteries and non contrast examination. Magnetic resonance imaging of the head is a painless, noninvasive test that produces detailed images of your brain and brain stem. An MRI machine creates the images using a magnetic field and radio waves, which produce as a cross sectional image to produce high quality two-dimensional or three-dimensional images of the brain and brainstem without the use of ionizing radiation (X-rays) or radioactive tracers.

One advantage of MRI of the brain over computed tomography of the head is better tissue contrast, and it has fewer artifacts than CT when viewing the brainstem. MRI is also superior for pituitary imaging. It may however be less effective at identifying early cerebritis.

A number of different imaging modalities or sequences can be used with imaging the nervous system:T1-weighted (T1W) images: Cerebrospinal fluid is dark. T1-weighted images are useful for visualizing normal anatomy.T2-weighted (T2W) images: CSF is light, but fat (and thus white matter) is darker than with T1. T2-weighted images are useful for visualizing pathology. Diffusion-weighted images (DWI): DWI uses the diffusion of water molecules to generate contrast in MR

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images. Proton density (PD) images: CSF has a relatively high level of protons, making CSF appear bright. Gray matter is brighter than white matter. Fluid attenuation inversion recovery (FLAIR): useful for evaluation of white matter plaques near the ventricles. It is useful in identifying demyelination. In this dissertation the data are collected MRI Brain examinations in various imaging protocols and positioning in MRI brain examination from the department of Radiodiagnosis and Imaging for the descriptive study.

II. TOPIC RELATED TO THE IMAGING PROTOCOL AND PATIENT POSITIONING IN MRI BRAIN

The topic for the study are selected from various the brain MRI cases in NIMS medical College and Hospital, Department of Radiodiagnosis and Imaging Jaipur, within the period of October 2019- March 2020.

B. SCAN PARAMETER

- Survey line not be in oblique angle
- Slice thickness 1mm – 3mm
- Axial scanned preferred (Sagittal scan acceptable)
- No concatenation, no fat sat, 3D scanned preferred
- Scan inferior to superior from hard palate to and including top vertex
- Matrix square 512x512
- Used soft tissue algorithm (contrast agent allowed)
- FOV Smallest to include patient's external soft tissue (particularly a tip of nose, top of head and ears)
- Exclude table or hardest from FOV
- Non overlapping slice with no gaps in between the slices

Routine MRI studies of the brain are performed in axial, coronal, sagittal axial in varying thickness from 5 to 10mm.T1 images have shorter TR (repetition time of <1000 msec) and short TE (echo tine <30msec).The T2WI have a long TR of over 1500msec.The first echo of T2 images with shorter TE is celled proton density, or balanced T1 and T2 images. The second echo of T2I with a longer TR of over 60msec represent real T2I The CSF has a long T1 which demonstrates low signal intensity in T1 but slightly higher in intensity in the first echo of T2I.In real T2 (long TE and very long TR), the CSF has very high signal intensity The basal ganglia, dentate muscles of the cerebellum, and red muscles of the mid brain have low signal intensities in T2W1 because of their mineral content. The gray matter has a slightly higher intensity in relation to white matter in almost all spin echo images.
Fat has a very high signal intensity in T1W1.Vascular structures show signal void in all regular T1,T2 and proton density images because of moving protons of circulating blood flowing CSF has the same effect, demonstrating signal void in the cerebral aqueduct.

PATIENT POSITIONING

- Before the patient position on the table all the metallic objects are removed from the body for the prevent of artifact during scanning
- Patient position – Supine
- Used head holder with fitted pad (Patient head separate from head holder)
- Not to use any immobilization devices (straps / tape) across patient forehead and instead of ear muffs use ear plugs for protection.
- No patient movement during scanning

SEQUENCE OF MRI

- T1 weighted sequences
- T2 weighted sequences
- Inversion recovery sequences
- fluid attenuation inversion recovery (FLAIR)
- short tau inversion recovery (STIR)
- PD weighted sequences
- Diffusion weighted sequences
- DWI
- ADC (Apparent diffusion coefficient maps)

CHAPTER 1

INFARCT

Stroke is an acute central nervous system injury of vascular origin which is having an abrupt onset.

Acute infarct	Chronic infarct
T1W Hypo intense signal	T1W hypo intense signal
T2 w Hyper intense signal	T2W hyper intense signal
FLAIR Hyper intense	FLAIR Hypo intense

MR angiography (MRA)
- plane: axial with reconstructions
- sequence: time of flight angiography
- purpose: assess for luminal diameter and occlusions

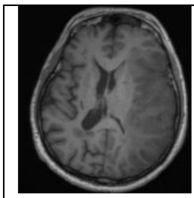
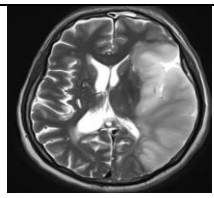
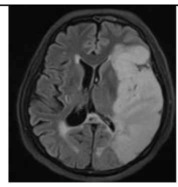
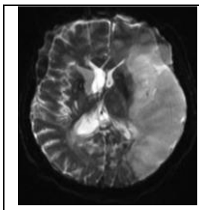
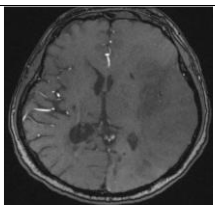
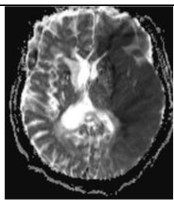
		

Figure 1 (a) : T1	Figure 1 (b) : T2	Figure 1 : (c) FLAIR

 Figure (d) : DWI	 Figure 1 (e) : MRA	 Figure 1 (f) : ADC

CHAPTER 2

HAEMORRGHAGE

A brain hemorrhage is a type of stroke. It's caused by an artery in the brain bursting and causing localized bleeding in the surrounding tissues. This bleeding kills brain cells.

Sequences

- Sagittal T1 SE,
- Axial PD/T2 SE
- Coronal T1 SE
- Axial FLAIR
- Axial T2* GRE
- Axial EP Diffusion.
- No IV contrast.

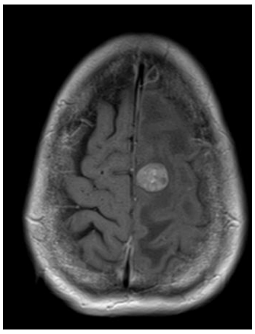


Figure 2 : T1 with contrast

CHAPTER 3

SUBDURAL HAEMORRGHAGE

Subdural hemorrhage (SDH) (also commonly called a subdural hematoma) is a collection of blood accumulating in the subdural space, the potential space between the dura and arachnoid mater of the meninges around the brain**.**

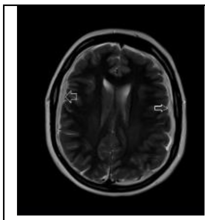
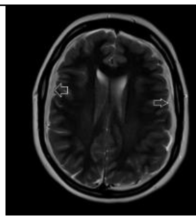
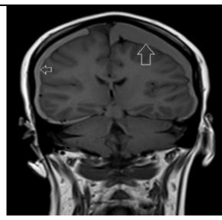
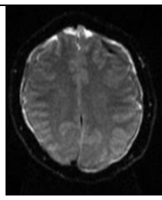
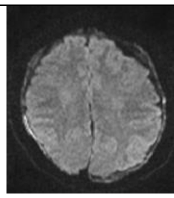
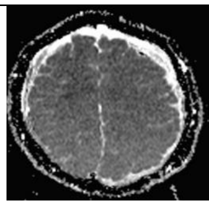
- T1:

Acute **-** Hypointense to isointense
Subacute **-** Hyperintense
Chronic **-** Hyperintense

- T2:

Acute **-** Hypointense
Subacute **-** Hypointense to hyperintense
Chronic – Hyperintense

FLAIR: Hyperintense at all stages

 **Figure** : 2(a) T2 Axial	 Figure: 2 (b) FLAIR Axial	 Figure : 2 (c)T1 coronal
 Figure :2 (d) Axial DWI	 Figure : 2 (e) DWI Axial B	 Figure :2 (f) DWI Axial ADC

CHAPTER 4

MENINGIOMA

A meningioma is a tumor that arises from the meninges — the membranes that surround your brain and spinal cord. Although not technically a brain tumor, it is included in this category because it may compress or squeeze the adjacent brain, nerves and vessels. Meningioma is the most common type of tumor that forms in the head

Sequences:

- T1 non enhanced: **-** T1-weighted non enhanced MRI image shows a (rarely hyperintense) homogeneous, hypointense round mass with thin capsule.

- T2 and FLAIR: **-** T2-weighted MRI image shows an isointense and inhomogeneous mass with peripheral edema indicating a more fibrous and harder character

- T1 enhanced: **-** T1-weighted enhanced MRI image shows a hyperintense homogeneous round mass with an enhancing tail involving the dura.

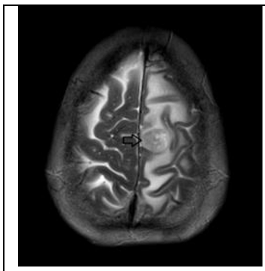


Figure: 3 (a) T2 Axial

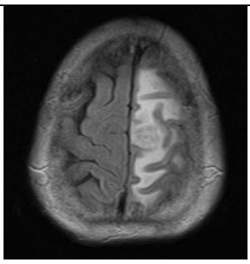


Figure:3 (b) FLAIR Axial

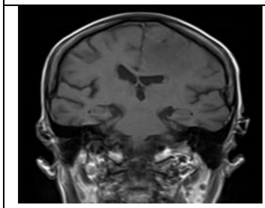


Figure : 3 (c) T1 Coronal pre contrast

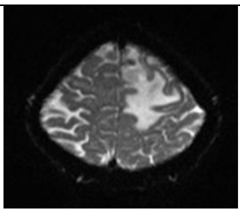


Figure :3 (d) Axial DWI

CHAPTER 5

HYDROCEPHALUS

Hydrocephalus is the buildup of fluid in the cavities (ventricles) deep within the brain. The excess fluid increases the size of the ventricles and puts pressure on the brain.

Cerebrospinal fluid normally flows through the ventricles and bathes the brain and spinal column. But the pressure of too much cerebrospinal fluid associated with hydrocephalus can damage brain tissues and cause a range of impairments in brain function.
Sequences

- T1 Axial
- T1 Sagittal
- FLAIR Axial
- Steady free state sagittal

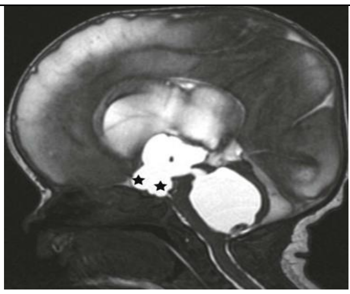


Figure :4 (a) Obstructive hydrocephalus. A midline sagittal balanced steady-state free precession image demonstrates the dilatation of the chiasmatic and infundibular recess of the third ventricle (stars). A dilated fourth ventricle also is noted in this patient with fourth ventricular outflow obstruction (an entrapped fourth ventricle) from neonatal hemorrhage.

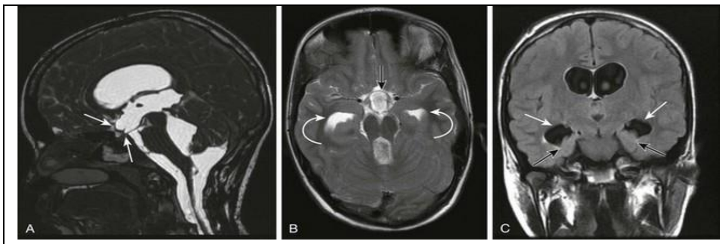


Figure : 4 (b) Magnetic resonance imaging findings in a patient with hydrocephalus. A, A midsagittal T1-weighted image in a 10-year-old girl with obstructive hydrocephalus demonstrates dilation of the chiasmatic and infundibular recesses (arrows). B, An axial fluid-attenuated inversion recovery image shows dilated anterior recess of the third ventricle (straight arrow). The temporal horns also are dilated (curved arrows), with a surrounding increase in signal suggestive of increased transependymal cerebrospinal fluid resorption. C, A coronal T2-weighted image shows the characteristic dilation of the temporal horns (white arrows) with enlargement of the choroidal fissure and inferomedial displacement of the hippocampus (black arrows).

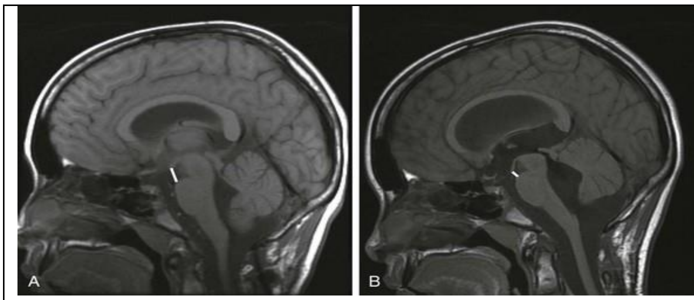


Figure: 4(c) The mamillopontine distance. **A,** A baseline T1-weighted, sagittal, midline, magnetic resonance image in this 11-year-old patient demonstrates normal mamillopontine distance. The distance (*bar*) is measured from the anterior base of the mamillary body to the top of the pons parallel to the anterior aspect of the mesencephalon. **B,** A reduction in the mamillopontine distance within 6 months as a result of interval development of hydrocephalus from an intraventricular hemorrhage. Note the stretching of the corpus callosum and the third ventricular dilation.

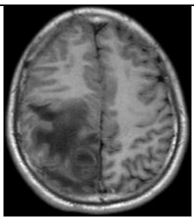
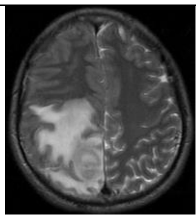
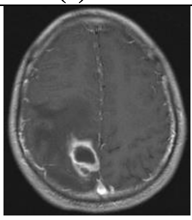
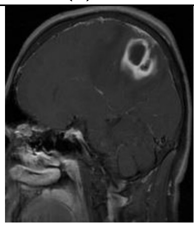
CHAPTER 6

BRAIN ABCESS

Cerebral abscesses result from pathogens growing within the brain parenchyma. Initial parenchymal infection is known as cerebritis, which may progress into a cerebral abscess. Historically direct extension from sinus or scalp infections was the most common source. More recently haematological spread has become most common.
MR images were obtained at

(A) axial pre-contrast spin echo T1WI (TR/TE 380/14 ms, 320×192 matrix),
(B) fat-suppressed fast spin echo T2WI (TR/TE 3900/84 ms) images as well as (C)axial and
(D)sagittal fat-suppressed, post-contrast spin echo T1WI were obtained utilizing a slice thickness of 5 mm.

MR perfusion: rCBV is reduced in the surrounding oedema cf. to both normal white matter and tumour oedema seen in high-grade gliomas
MR spectroscopy: elevation of a succinate peak is relatively specific but not present in all abscesses; high lactate, acetate, alanine, valine, leucine, and isoleucine levels peak may be present;

 Figure :5 (a) Axial T1 W1	 Figure :5 (b) Axial-T2WI
 Figure :5 (a) Axi-T1 with Contrast	 Figure :5 (b) Sag-T1WI+C

This 35-year-old man presented to the emergency department complaining of intermittent headaches, paresthesias, and weakness of his left thumb for nine days. The patient reported a history of fever along with these symptoms. After the MRI examination illustrated herein, the patient underwent successful surgical treatment.

CHAPTER 7

NEUROCYSTIROSIS

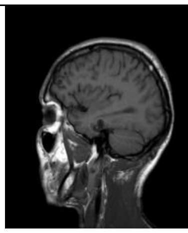
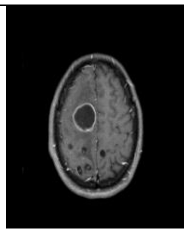
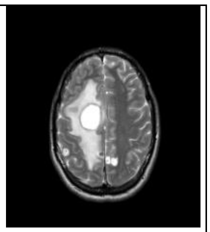
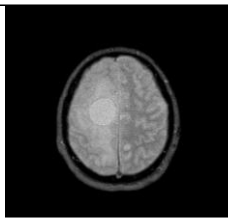
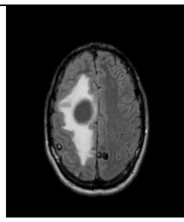
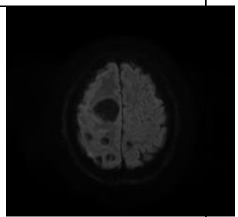
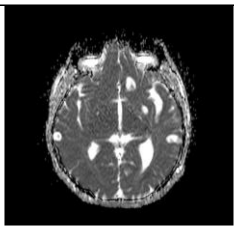
Neurocysticercosis, the infection caused by the larval form of the tapeworm Taenia solium, is the most common parasitic disease of the central nervous system and the most common cause of acquired epilepsy worldwide. The larval cysts can infect various parts of the body causing a condition known as cysticercosis

- T1 Axial
- T1 Sagittal
- T2 Axial
- FLAIR Axial
- ADC Axial

CHAPTER 8

TUBERCULOMA

Tuberculomas or tuberculous granulomas are well defined focal masses that result from Mycobacterium tuberculosis infection and are one of the more severe morphological forms of tuberculosis. Tuberculomas most commonly occur in the brain and the lungs.

 Figure: 6 (a) Sagittal T1	 Figure :6(b)Axial T1	 Figure :6 (c) Axial T2
 Figure : 6 (e) Axial GRE	 Figure :6 (d) Axial FLAIR	 Figure : 6 (f) Axial DWI
 Figure : 6 (f) Axial ADC		

- T1 Axial
- T2 Axial
- FLAIR Axial
- T2 Coronal
- T1 Sagittal
- Axial ADC
- Axial T1 with contrast
- T1 with contrast coronal

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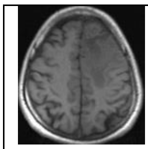
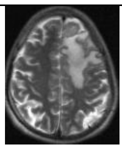
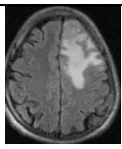
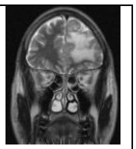
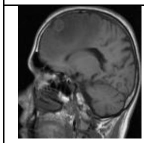
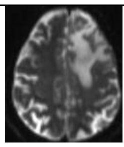
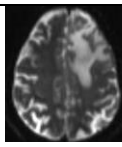
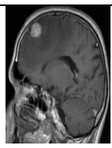
 Figure : 7 (d) Coronal T2	 Figure:11 (b)Axial T2	 Figure :7(c) AxialFLAIR	 Figure:7(d)Coronal T2
 Figure :7 (e) Sagittal T1	 Figure:7(f) Axial ADC	 Figure:7(g) AxialT1+C	 Figure :7(h) Coronal T1

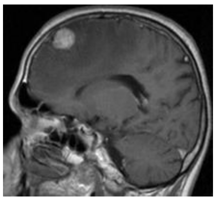


Figure :7 (i) Sagittal T1 + Contrast

MRI demonstrates a 2cm rounded lesion in the anterior pole of the left frontal lobe. The lesion is mostly isointense to grey matter, with perhaps small regions of hyperintensity on T1 and T2 weighted images. Of note, there is no well defined central region of T2 hyperintensity. Very extensive vasogenic oedema is present extending back to the precentral region. ADC demonstrates increased values centrally, making a conventional bacterial abscess unlikely.

Following administration of contrast the lesion enhances relatively homogeneously.

CHAPTER 10

BRAIN TUMOUR

A brain tumor is a mass or growth of abnormal cells in your brain. Many different types of brain tumors exist. Some brain tumors are noncancerous (benign), and some brain tumors are cancerous (malignant). Brain tumors can begin in your brain (primary brain tumors), or cancer can begin in other parts of your body and spread to your brain (secondary, or metastatic, brain tumors).

Sequences

- T1 weighted

plane: axial and sagittal (or volumetric 3D)
sequence: fast-spin echo (T1 FSE) or gradient (T1 MPRAGE)
purpose: anatomical overview, which includes the soft tissues below the base of skull

- T2 weighted

plane: axial

- sequence: T2 FSE

purpose: evaluation of basal cisterns, ventricular system and subdural spaces, evaluation of vasogenic oedema, and good visualization of flow-voids in vessels

- FLAIR

plane: axial
sequence: FLAIR
purpose: assessment of white-matter tumor involvement and related vasogenic oedema

- diffusion-weighted imaging (DWI)

plane: axial
sequence: DWI: B=0, B=1000 and ADC
purpose: evaluation of the tumor cellularity

- post contrast sequences

plane: axial and coronal (at least two different planes or volumetric 3D)
sequence: post-contrast fast-spin echo (T1 FSE) or gradient (T1 MPRAGE) . A fat-saturated sequence is considered in at least one plane, especially when tumor involves the skull's base Gadolinium-based contrast agents (GBCAs) for CNS: gadoterate meglumine all these GBCAs are approved by FDA at identical administered total doses of 0.1mmol/kg body weight 1 susceptibility weighted imaging (SWI)
plane: axial
sequence: susceptibility weighted imaging (ideal) or T2*
purpose: identify blood products or calcification within the tumour
When assessing gliomas it is relevant to include advanced MRI sequences, such as:

- MR perfusion

purpose: elevation in rCBV is generally related with a high-grade tumor. It also helps in the evaluation of pseudo progression and pseudo response

- Spectroscopy

sequence: single or multivoxel spectroscopy
purpose: metabolic peaks characterization

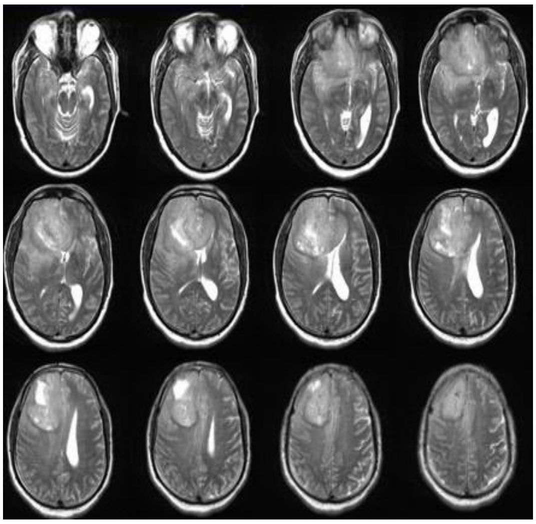


Figure 13 : T1 with contrast image

CHAPTER 11

METASTASIS

Brain metastases occur when cancer cells spread from their original site to the brain. Any cancer can spread to the brain, but the types most likely to cause brain metastases are lung, breast, colon, kidney and melanoma.

Sequences

- T1

typically iso- to hypointense
if hemorrhagic may have intrinsic high signal
non-hemorrhagic melanoma metastases can also have intrinsic high signal due to the paramagnetic properties of melanin

- T1C+

enhancement pattern can be uniform, punctuate, or ring-enhancing, but it is usually intense
delayed sequences may show additional lesions, therefore contrast-enhanced MR is the current standard for small metastases detection

- T2

typically hyperintense
hemorrhage may alter this
FLAIR
typically hyperintense
hyperintense peri-tumoural edema of variable amounts
DWI/ADC
edema is out of proportion with tumor size and appears dark on DWI
ADC demonstrates facilitated diffusion in oedema

MR spectroscopy
intratumoural choline peak with no choline elevation in the peritumoural oedema
any tumor necrosis results in a lipid peak NAA depleted

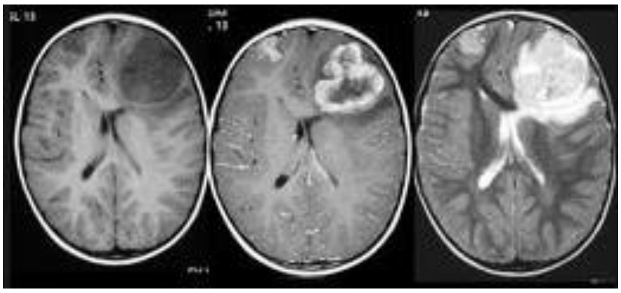


Figure :14 T1 ,T1 with contrast

RESULTS

A total of 50 MRI brain examination were reviewed, consisting of 34 males and 26 females. Their age range is from 10-70 years. The table show the age distribution of patients. The most common and affected age groups in males are51-60 and in females 41-60 years respectively. And out of 50 patients examination reviewed Neurology are the most referred department to patients for examination of MRI brain.

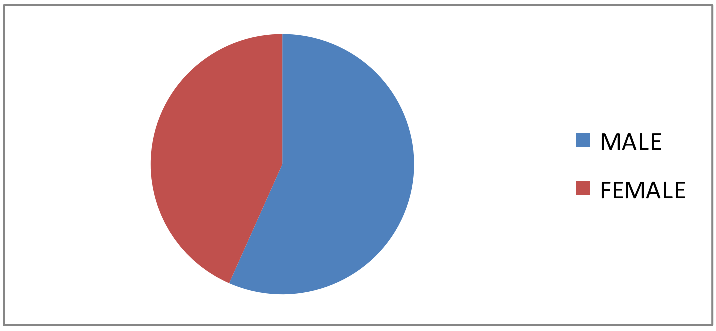


Figure : 15 Total number of Scan = 50 MALE 34 Female 26

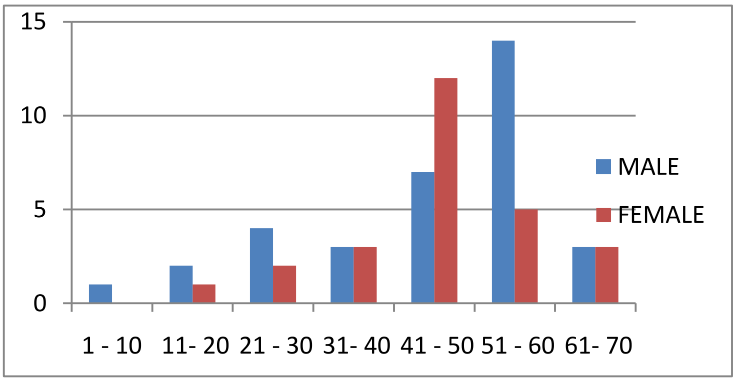


Figure 16 : The age group determinations of patients

III. CONCLUSION

The imaging protocols and patients preparation in MRI Brain exam illustrates general principles that are applicable. Each user, however, has specific needs preferences, and categories of patient pathology and age group as well, and may be constrained by available hardware and software in machine and computer. Each imaging protocol should be the right mix of speed, resolution and image quality, but because of specific user specific variables. It is a difficult to recommended a standard set of protocols. A solution of that work effectively at our institution will the establishment of a regular protocol meeting and discuss composed of radiology staff, including MRI technologists and MRI physicists. Modified a new protocol is review, discuss and implemented.

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