A PROSPECTIVE REVIEW OF THE IMAGING FINDINGS IN MAGNETIC RESONANCE IMAGING OF THE BRAIN

This dissertation is submitted in part fulfillment for the Degree of Master of Medicine in Diagnostic Radiology of the University of Nairobi.

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This dissertation is my original work and has not been presented for a degree in any other university

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DEDICATION

I would like to dedicate this work to my son Pratik, whose sweet smiles and innocent looks have been a source of great encouragement to me.

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SUMMARY

A prospective study was conducted at the Diagnostic Center in Nairobi, Kenya between the period January 1 – December 31 2003. The aim of the study was to analyze the pattern, age and sex distribution of cranial pathologies as shown by MRI, and to compare the findings of MRI with CT scan for diagnosis of cranial pathologies. The sample population included patients who had undergone a cranial MRI examination at the Diagnostic Center during the study period.

A total of 565 cases were analyzed. The age of the patients varied from 2 months to 86 years. There were 300 (53.1%) male patients and 265 (46.9%) female patients, giving a male to female ratio of 1.13:1.

The single most common symptom recorded in the 565 patients was headache, which was seen in 157 (27.8%) patients. Other symptoms (nausea, vomiting, memory loss, visual impairment, vertigo, weakness of limbs and face, hearing impairment dementia, etc.) with or without headache were observed in 408 (72.2%) patients.

Ischaemic changes were the frequently diagnosed intra-cranial pathologies, being present in 48 patients (8.5%). The mean age of patients diagnosed with ischaemia was 56 years, while the male to female ratio was 3:1. Dementia constituted the major presenting symptom, seen in 20 (41%) patients, followed by twitching and numbness around the lips in 8 patients (16%). The regions most frequently involved in ischaemic changes were the peri ventricular and para ventricular areas (35%) followed by parietal lobe (31% of cases). Ischaemic changes were characterized by increased signals on T2W images.

Infarction was diagnosed in 45 patients (8%). Out of these 12 patients had lacunar infarcts. The mean age of patients diagnosed, as having infarction was 62 years with male to female ratio of 1.5.1. Infarction was most frequently found in the region of parietal lobe (26%), followed by frontal lobe (13%). Mean age of patients diagnosed, as having lacunar infarction was 65 years. Lacunar infarcts are found most frequently in thalamus (25%), followed by basal ganglia region (20%). Acute infarctions were characterized by high signals on T2W and FLAIR images. Chronic infarctions were characterized by a high signal on T2W images and associated changes such as brain atrophy and encephalomalacia.

Tumors were diagnosed in 48 (8.5%) out of the 565 patients. The mean age of patients diagnosed with tumor was 41 years. The female patients constituted 48% and male patients constitute 52% of cases giving a male to female ratio of 1.1:1.
Headaches along with other symptoms (vomiting, cerebellar signs, nerve symptoms) were the most common presenting symptoms in patients with tumors, being present in 50% of patients. Glioma was the most frequently diagnosed tumor (14 patients) followed by meningioma (8 patients). Tumors were most frequently distributed in the frontal lobe (20.8%) and parietal lobe (20.8%),

Infection was diagnosed in 16 (2.8%) patients. The mean age of patients suffering from infection was 27 years with a male to female ratio of 1.6:1. Headaches along with other symptoms (fever, nausea, vomiting, photophobia, convulsions) were the main presenting symptom being present in 45.8% of the patients. The region most frequently involved was the parietal lobe (43.75%). Infective lesions were characterized by low signal on T1W and high signal on T2W images, with post contrast enhancement.

Demyelinating conditions were diagnosed in 19 (3.4%) patients. The mean age of the patients diagnosed as having demyelination was 34 years with male to female ratio of 1.3:1. Headache and convulsions were the most common presenting symptoms. The lesions were characterized by high signal on T2W and FLAIR images.

Intracranial bleeds were diagnosed in 8 patients, whose mean age was 53 years and having a male to female ratio of 1.8:1. 75% of the patients had subacute subdural bleed, characterized by high signal on T1W and T2W images.

AV malformation was diagnosed in 3 patients having a mean age of 35 years, and a male to female ratio of 1:2.

Mesial temporal sclerosis was diagnosed in 9 patients having a male to female ratio of 2:1. Convulsion was the most common presenting symptom (85%) in this condition. The lesions were characterized by increased signal on T2W images and reduction in size of the hippocampal region with dilatation of the temporal hom.

A follow up examination was performed in 65 patients whose mean age was 40 years and a male to female ratio of 1:1.3. Out of these 65 cases for follow up, 31 cases had tumor, 11 cases had intra-cerebral bleed and 5 cases had intra-cranial infection.

244 (43.2%) cases were normal. The mean age of presentation was 37 years with male to female ratio of 1:1.1. Among the normal patients the most common presenting symptom was headache (seen in 60.7% of cases).

MRI was found to be more useful than CT in detecting intracranial pathologies especially infarction, demyelinating conditions, Mesial temporal sclerosis and infection.

The reliability of the MRI technique in diagnosing intra-cranial lesions is discussed. It is hoped that the results of this study will enhance the use of the MRI technique in the diagnosis of intra-cranial lesions.

STUDY RATIONALE

The study is relevant to practice of medicine in Kenya, as the CNS pathologies are highly prevalent especially in HIV/AIDS and elderly patients.
MRI has a high soft tissue contrast and resolution, and its multiplanar capabilities make it the technique of choice among those who can afford it. . It is non-invasive and does not expose the patient to ionizing radiation. MRI has been around in Kenya for over 5 years and there is no local data on its role in the imaging setup in Kenya.

Cranial pathologies are frequently encountered in clinical practice and imaging plays a pivotal role in the diagnosis and management of patients. MRI is a highly sensitive imaging modality for the evaluation of cranial pathologies. It is a relatively new imaging modality in Kenya, having been established in 1997. This study reviews the findings of the MRI of the brain prospectively in the year 2003.

A study of this nature has not been undertaken in the past in Kenya. This study analyzes the patterns and presentations of different intra-cranial pathologies and compares the role of MRI relative to CT scan in the evaluation of these pathologies. It is expected that the results of the study will enhance the understanding of different pathologies and their varying appearances as shown by MRI.

Due to its excellent soft tissue resolution and multi planar capabilities, the MRI technique is superior to other imaging modalities for examination of the central nervous system. The effective and efficient use of MRI in our setting will benefit the patient in terms of safer and cost effective diagnostic imaging, leading to earlier diagnosis and improved management of brain pathologies.

MRI is more expensive than other imaging modalities and has limited availability. There are certain conditions where MRI is contraindicated which include permanent cardiac pacemaker, ferromagnetic foreign body in the eye, cochlear implants, metallic intra-cranial clips, etc. Furthermore MRI is considered to be less sensitive in evaluation of bony lesions and intra-cerebral calcifications. However, there are certain situations when it is better to perform an MRI examination as the initial investigation, as it will often lead to a more definitive diagnosis in the majority of brain pathologies.

Michael Brant-Zawazki in his paper "MR Imaging of brain tumor" [(1)] states that MRI has greater sensitivity to pathological alterations of cerebral tissue and assures the replacement of CT by MRI as first line diagnostic imaging for most patients with neurological manifestations. According to Patrick Y .Wen et al, MRI is more sensitive than CT enabling detection of small tumors and lesions that may be missed by CT scan. They conclude that MRI provides much greater anatomic details in multiple planes and is especially useful for visualizing skull base, brain stem, and posterior fossa tumors [(2)].

There is need to review the choice of imaging modalities for the examination of central nervous system. It is intended that the study will lead to better utilization of MRI in our local set up. This is especially true when the patient has to undergo a series of expensive and often invasive investigations without a definitive diagnosis. Furthermore the study will provide an opportunity for better understanding of different MRI protocols.

STUDY OBJECTIVES

- To establish the age and sex distribution of different cranial pathologies as seen by MRI.
- To establish the common symptoms for which MRI is requested and modes of presentation of different cranial pathologies. (Based on the history given by the referring doctor)
- To establish the pattern of different cranial pathologies and their distribution in the brain as shown by MRI.
- To compare the findings of MRI with CT scan (in cases where a previous CT scan report was available)

ABBREVIATIONS USED

AJR	American Journal of Radiology
BJR	British Journal of Radiology
CSF	Cerebrospinal Fluid
CT	Computerized Tomography
KNH	Kenyatta National Hospital
MITC	Medical Imaging and Therapeutic Center
MRI	Magnetic Resonance Imaging
T1 W	T1 weighted images
T2W	T2 weighted images
STIR	Short T1 inversion recovery
FLAIR	Fluid Attenuated Inversion Recovery
DTPA	Dimeglumine penta acetic acid
CPA	Cerebello pontine Angle
RF	Radio frequency
MRA	Magnetic Resonance Angiography
CTA	Computed Tomography Angiography
TE	Echo Time
TR	Repetition time
STIR	Short Tau Inversion Recovery
MS	Multiple Sclerosis
T	Table
C	Pie charts
G	Graphs

INTRODUCTION

The approach to the investigation of patients presenting with cranial pathologies has undergone a radical change over the last few years. The different imaging modalities along with their advantages and disadvantages are discussed.

In the past most cranial conditions were evaluated by conventional radiography. The bony structures, calcifications and vascular grooves are well shown on plain radiography. However, due to superimposition of various shadows it is difficult to reach a definitive diagnosis based only on plain radiographs. Plain radiography gives a gross and vague idea of the existing pathology and subjects the patient to ionizing radiation. Though, still used as a first line of investigation for patients with cranial lesions, the diagnostic yield is usually poor.

Angiography plays an important role in detection and evaluation of aneurysms, vascular malformations and assessment of the vascularity of lesions. However, Angiography has been superseded by newer noninvasive techniques such as MRA and CTA. Angiography is an invasive procedure with its inherent complications and it subjects the patient to high radiation dose. Thus, its indications are limited mainly to evaluation of aneurysms, vascular malformations and tumors. A key role of Angiography is in interventional procedures where it is often possible to replace an invasive surgery. In many situations, surgery can be performed more easily, for example after embolisation of tumor vasculature.

Ultrasound is useful in infants before the anterior fontanelles are closed. It is readily available, does not use ionization radiation, and is portable and relatively inexpensive. However its primary disadvantage is that, it has a high operator dependency and is predominantly limited to infants and children.

CT gives good soft tissue resolution and is the best imaging modality for the evaluation of bony structures and calcifications. CT determines the size, extent and the effect of the intra-cranial lesions on the surrounding brain parenchyma. It has better resolution than Ultrasound and is not operator dependent. However, CT scan subjects the patient to a high radiation dose and is less sensitive in diagnosis of certain intra-cranial pathologies especially of the posterior cranial fossa. This is due to streak and beam hardening artifacts, which may limit the effectiveness of CT in evaluation of structures closely related to dense bone. The images are obtained only in the axial and coronal planes. Due to limited soft tissue resolution, the differentiation of tumor, infarct, infection and demyelinating conditions can be difficult on CT.

MRI has revolutionized brain imaging by its excellent soft tissue contrast resolution and multi-planar imaging capabilities. It does not utilize ionizing radiations like CT Scan. The MRI modality's inherent sensitivity to changes in brain water content caused by various insults is well established. This would explain the increased sensitivity of MRI to wide range of pathologies. MRI allows unique depiction of blood vessels including the velocity of flow within [(3)]. This allows evaluation of vessels including arteries, veins and dural venous sinuses. It is being used as first line diagnostic imaging study for most patients with neurological symptoms[1]. Absence of beam hardening artifacts, multi-plannar imaging capabilities and greater intrinsic soft tissue contrast are emphasized as significant advantages of MRI [(4)]. However, MRI has the disadvantage of being costly, limited availability, claustrophobic for some patients and contraindicated in few patients.

It is anticipated that MRI technology will be available to a wider patient base at affordable rates in the near future. This study is conducted in order to obtain a basic concept of the appearances of different cranial lesions by MRI and to correlate the findings to the presenting symptoms of the patients. The study also discusses various MRI techniques and procedures and will attempt to compare CT and MRI in patients where both studies were performed.

LITERATURE REVIEW

The imaging of central nervous system has undergone radical change over the last few decades. The newer imaging modalities like CT scan, MRI and MRI Spectroscopy have come to play a pivotal role in diagnosis and management of patients with intracranial pathologies. MRI due to its excellent soft tissue resolution and multilpanar capabilities is considered to be the imaging modality of choice for diagnosis of most cranial abnormalities. The pattern of various intracranial lesions and their appearance on MRI is discussed.

Ischaemic lesions:

Brain ischemia is probably the most common entity seen on MRI [5]. It is evident, when the blood flood to the brain is either decreased in a focal or a global fashion. Focal decrease generally affects major vascular territories such as middle cerebral, posterior cerebral and basilar artery distribution. Global ischemia affects the distal zone of supply in the deep hemisphere at the junction of 2 major vascular territories, and in deep basal ganglia. It is associated with hyaline and thrombotic vasculopathy affecting the arterioles of long penetrating arteries. Generally, grey matter is more susceptible than the white matter, but in global ischemia white matter may bear the brunt of insult. Ischemia causes prolongation of both T_1W and T_2W relaxation time resulting in decreased signal intensity on T_1W and high intensity signals on T_2W images. [6]

Infarcts:

Infarcts are characterized by necrosis, axonal loss and demyelination due to reduced blood supply. Infarcts give increased signals on T2W and low signals on T1W images. Acute infarcts are associated with edema and mass effect and characteristically give increased signal on T2W and FLAIR images. Secondary hemorrhages are quite common in the infarcts, in which case there is preferential shortening of T_2W relaxation time with high field strength [6]. Reactive astrocytes oriented along the degenerated axon extend from the central infarct. This is called isomorphic gliosis and is associated with increased intensity on T_2W weighted images [7]. Chronic infarcts are associated with gliosis, encephalomalacia and atrophy of surrounding brain parenchyma.

Tumors:

MRI is being used as the imaging modality of choice to provide accurate localization of masses in the brain. Tumors can be benign or malignant. Malignant tumors of the brain can be primary brain tumor or metastasis from a distant neoplasm. Two thirds of all brain tumors are primary neoplasms [8]. Differentiation of a mass into extra axial or intra axial location is important as it gives an important clue to the diagnosis of the lesion. Extra axial lesions may cause displacement of grey-white matter interface, changes in the underlying bone, and are characterized by presence of CSF cleft between the tumor and the cerebral cortex. Extra axial lesions derive their blood supply from the branches of external carotid artery, whereas intra axial lesions get their blood supply from the branches of internal carotid artery or basilo- vertebral system.

Gliomas: Glial cells are the most common cellular component of the neuronal tissue. Almost half of all primary brain tumors are Glioma. [8].

The hallmark of primary brain tumor is a single, contiguous lesion with increased signals in T_2W images, and low intensity signal on T_1W images and presence of edema and mass effect. The degree of mass effect of Glioma is often small given the size and extent of tumor [1]. Astrocytic Gliomas account for more than three fourth of Gliomas and are the commonest supra tentorial neoplasm in all age groups [9]. In children, gliomas are relatively benign tumors, in young adults low-grade astrocytomas predominate, whereas anaplastic astrocytomas have a peak incidence around 40 years and Glioblastoma multiforme usually occurs after 40 years.

The WHO system for grading of Gliomas distinguishes between well-circumscribed lesions with low proliferative potential (grade 1) on one hand, and diffusely infiltrating (Grade 2-4) lesions on the other hand. [10]

Most low grade Gliomas are hyperintense on T2W images and hypo/isointense on T1W images. The vasogenic edema and contrast enhancement is minimal. Anaplastic astrocytomas have same signal intensity on T1W and T2W images as low grade Gliomas, but are usually associated with edema and show contrast enhancement. Glioblastoma multiforme typically has heterogeneous signal on MRI and are associated with more extensive edema and contrast enhancement as compared to the former types. [10].

Meningiomas: Meningiomas are the most common nonglial extradural primary brain tumors [11]. It constitutes 15% of primary brain tumours and originates from the arachnoid cell rests. Most of the tumours give the same signal intensity as the cerebral cortex on both T1W and T2W images. Meningiomas show intense enhancement after IV contrast is given. Meningiomas may show hyperostosis of the underlying bone and there may be calcification in 15% of cases. [13]

As per WHO classification meningiomas can be classified into typical benign meningiomas (majority of tumours), atypical meningiomas, and anaplastic malignant meningiomas (less than 2%) [14]

Pituitary tumors: Pituitary adenomas are the most common neoplasm in the sellar region. They are classified as micro adenomas (maximum diameter <1 cms) and macro adenomas (>1cms). They become symptomatic either due to their endocrine activity or by the mass effect they exert, usually manifested by visual symptoms [15]

MRI of sella is the most sensitive method for localization of pituitary adenoma. A focal glandular hypo intensity identified on coronal images was found to be the most sensitive predictor of micro adenoma by Wallace W Peck, William P Dillon et al [16]. MRI is the investigation of choice for pituitary tumors, standard protocol being 3mm coronal T 1 W spin echo sequences through the pituitary gland before and after I V Gadolinium [10].

Craniopharyngiomas: These are benign tumors arising from the epithelial remnants of Rathke's pouch. They are found most frequently in childhood. They arise in a suprasellar location and characteristically expand postero- superiorly towards the third ventricle. They have solid and cystic components, show contrast enhancement and may be calcified. They may also contain fat or blood. [10].

Acoustic Schwanoma: MRI is study of choice in these tumors because of its high sensitivity especially after the use of contrast media. They arise from nerve sheath of 8th cranial nerve most frequently, the vestibular portion [17]. Differentiation of meningioma from acoustic neuromas by MRI is provided most reliably by separation of meningioma from porus acusticus and 7th and 8th nerves and not by signal intensity differences [4].

Metastasis: The primary neoplasms metastasizing most commonly to the brain are carcinoma of lung, breast, kidney, and malignant melanoma [9]. The hallmark of metastatic tumours is multiplicity. They have a tendency to seed peripherally in the cerebral substance, at grey-white matter junction. Often metastasis is seen as foci of subtle to obvious hyper intensity on T2W images surrounded by variable amount of vasogenic edema. These lesions enhance strongly after IV contrast. T1W images may show a nidus as hypo intense area or may depict focal hemorrhage in the nidus. [1]

Phakomatosis

Von Hippel-Lindau: Its manifestations include retinal angiomas, renal and pancreatic tumors and multiple hemangioblastomas of the central nervous system especially in the cerebellum and the spinal cord. Hemangioblastomas are often cystic but can be solid and show marked enhancement of the tumor nodule or the solid component. [10].

Infection:

MRI demonstrates parenchymal brain infection with high sensitivity. The evolution of classical bacterial cerebritis into mature abscess stage can be readily monitored [1]. Reaction of the brain tissue to infection is cerebritis and if untreated may be followed by abscess formation. Initially in the course of disease T_1W images show indistinct low intensity signals and T_2W images show hyper intensity .As necrosis becomes confluent, lengthening of T_1 and T_2 relaxation time occurs. Lesions show post IV contrast enhancement. [18].

Bacterial meningitis: It may result from haematogenous spread of infection or may be due to direct spread of infection from paranasal sinuses or mastoid air cells. The breakdown of leptomeningeal blood brain barrier permits dissemination of bacteria into the subarachnoid space. The lesions enhance with gadopentetate dimeglumine. MRI is superior to CT in evaluation of complications of meningitis, including subdural empyma, dural venous thrombosis, secondary ischemia, and parenchymal lesions [19].

Tuberculous meningitis: Chronic meningitis is the most frequent presentation followed tuberculomas. Eighty six percent of children with tuberculosis meningitis are reported to have concomitant miliary tuberculosis of brain. MRI is more sensitive than CT in detecting lesions affecting the basal cisterns and tuberculomas of cerebral parenchyma [(20)]. Exudates appear as rather extensive areas of mild hypo intensity in the basal cistern on T1 W images. On T 2 W images, high intensity signals appear in these areas. Intense enhancement is seen post IV contrast. [(18)]

Abscess: It is defined as a focal, encapsulated, pus-containing cavity [(21)]. Distinctive MRI features of pyogenic abscess afford early and accurate diagnosis. The features include:

(1) Central necrosis with abscess fluid hypo intense relative to white matter and hyper intense relative to CSF on T1W scans and hyper intense relative to gray matter on T2W scans
(2) Abscess capsule that was iso to mildly hyper intense relative to brain on T1W images and iso to hypo intense relative to white matter on T2W images.
(3) Peripheral edema producing mild hypo intensity on T1W images and marked hyper intense on T2W images.
(4) Extra parenchymal spread

Spread of inflammation into ventricles and sub arachnoid spaces is more conspicuous on MRI than CT [(22)].

Haemorrhagic lesion:

Cranial hemorrhage can be divided into extra axial and intra axial lesions. Extra axial lesion comprise of extra dural bleed, sub dural bleed and sub arachnoid hemorrhage. Intra axial lesions comprise intra cerebral hemorrhage and intra ventricular bleed. Intra cerebral and extra cerebral hemorrhages are easily recognized on MRI with the exception of sub arachnoid hemorrhage, which is difficult to identify on spin echo sequences. [(23)] However FLAIR sequences are very sensitive in detection of sub arachnoid hemorrhage. The various stages of evolving haematoma are summarized below [(24)].

STAGES	FORM OF HAEM IRON	T1W MRI	T2W MRI
Hyper acute	Oxyhaemoglobin	Iso-hypointense	Slightly hyperintense
Acute (3-7) days	Deoxyhaemoglobin	Slightly hypointense	Hypointense
Early subacute (3-7 days)	Intracellular methaemoglobin	Hyperintense	Hypointense
Late subacute (1-4 weeks)	Extra cellular methaemoglobin	Hyperintense	Hyperintense
Chronic	Haemosiderin	Iso-or hypointense	Hyperintense

Arteriovenous malformations:

AVMs are a complex network of abnormal vascular channels that consists of arterial feeders, venous collaterals, the AVM nidus, and enlarged venous outflow channels [(25)].

The advantage of MRI over CT and Angiography include identification of signal void within the patent lumen, laminated thrombus, adjacent parenchymal edema and hemorrhage; and parent vessel as well as definition of an extra axial location with mass effect [(26)].

Cavernomas are A-V malformations consisting of widely open vascular spaces with little intervening tissue and evidence of recent and old hemorrhage. Cavernomas appear as rounded multilobular lesions of mixed signal intensity surrounded by dark haemosiderin rim. [(24)].

White matter disease:

Demyelinating disorders: MRI is the imaging modality of choice. MRI can distinguish stages of demyelination in degenerating nerves, there by providing a powerful method of diagnosis, and characterization of demyelinating diseases [(27)]. The patients usually present non-specific signs and symptoms such as headache, dizziness, and nausea to recurrent sensory changes. A negative examination with a highly sensitive technique greatly reassures the treating physician. Given the sensitivity of MRI imaging to demyelinating diseases, normal myelination of infant brain can be monitored readily with this tool [(1)].

Multiple Sclerosis: Contrast enhanced MRI is more sensitive than clinical monitoring for detecting new disease activity, and may be useful in evaluation of therapeutic regime [(28)]. Lesions are usually homogeneously iso intense or hypo intense on T1 w images and hyper intense on T 2 w images. The lesions are oval in shape located predominantly in the deep white matter close to the ventricles, most numerous posteriorly. Lesions in deep cerebellar white matter, middle cerebellar peduncle, brain stem and corpus callosum are characteristic. Acute lesions are larger and show contrast enhancement. Chronic lesions on MRI show a "target like appearance " where there is a peripheral rim that returns signal of less intensity than the central lesion [(29)].

Congenital Malforations:

MRI is highly sensitive to show the normal myelination of brain [(1)] and is used for the assessment of the normal maturation and structural development of the neonatal brain. T_1W images are superior then T_2W images in 1st six months of life. T_2W images are superior to T_1W images for assessment of maturation of cerebellum and brain stem. MRI is more sensitive than CT in detecting structural abnormalities as well as other abnormalities, including area of pachygyria, polymicrogyria, and heterotopic gray matter.

Corpus callosum abnormalities: Corpus callosum may be partially formed (dysgenesis) or completely absent (agenesis) .The anterior part is formed before the posterior part, thus a small or absent genu or body, with an intact splenium and rostrum, indicates secondary destruction rather than abnormal development.

Abnormalities of corpus callosum are commonly associated with other congenital malformations of the brain such as Chairi 2, Dandy Walker malformation, lipoma, abnormalities of neuronal migration and organization, dysraphic abnormalities encephalocele and midline facial abnormalities. [30].

Dandy walker Malformation: The malformation consists of complete or partial agenesis of the vermis, hypoplastic cerebellar hemispheres, and a large cyst in the posterior fossa resulting in a large posterior fossa with upward displacement of tentorium, torcula and transverse sinuses. A typical associated finding though not always present is supratentorial hydrocephalus. MRI is the imaging modality of choice for diagnosis and evaluation of the malformation. [31].

Chiari malformation:It is a congenital malformation of the hindbrain in a posterior fossa that is small. Almost all cases are associated with cephalocele or myelomeningocele. Patients usually present with hydrocephalus. The malformation consists of inferior displacement of the cerebellum, pons, medulla oblongata and cervical cord. Associated features include an inferiorly displaced and elongated fourth ventricle, beaking of the tectum, flattening of ventral pons and low attachment of the tentorium. Cerebellum herniates upwards into the supratentorial space and foramen magnum is often enlarged. MRI is highly sensitive in depicting the anatomical details and detection of complications. [32]

Clinical conditions:

Headache

A variety of vasoactive substances have been implicated in the etiology of headache. It is felt that blood vessel changes in the meninges give rise to headaches. Headache is a very common clinical symptom and imaging is not indicated in every patient presenting with headache. Feild and Wang suggested the following criteria's for selection of imaging patients presenting with headache:

First or worst headache
Increased frequency or severity
New onset after age of 50
New onset with history of cancer or immunodeficiency
Headache with mental status changes
Headaches with fever and meningeal signs

Epilepsy: MRI is qualitatively better than CT in evaluation of temporal lobe lesions and in diagnosis of psychomotor seizure disorders. There is evidence to suggest that temporal lobe gliosis, which frequently represent the morphologic substrate of psychomotor epilepsy, can be seen on MRI [33]. The major role of MRI in epileptic fits is to exclude a potentially treatable abnormality. The lesions that are usually identified are malignant cerebral tumors, benign tumors, changes secondary to ischemia, trauma and demyelination, mesial temporal sclerosis, congenital abnormalities and infection [34].

Other intracranial abnormalities
Mesial Temporal Sclerosis: This is by far the most common detectable structural lesion seen in association with temporal lobe epilepsy, the commonest of partial epilepsies. The etiology is ischaemic insult to the brain either in utero or in early neonatal period. The signs of hippocampal sclerosis on MRI are (1) volume loss, and (2) increased signal on T2W images [35].

Benign intracranial hypertension: The patients are typically middle aged female, obese and complaining of headache and visual disturbances. All patients have elevated pressure at lumbar puncture. There is no white signal abnormality. Although the sub arachnoid space is enlarged, the wide range of normal value would limit the clinical use of MRI. The role of MRI or CT is primarily in exclusion of other diseases, with clinical presentation similar to IIH [36].

Empty Sella Syndrome:It is a term applied to an enlarged pituitary fossa, which is mainly filled with CSF. Sometimes, it can be a manifestation of involution of a silent pituitary tumour, or may reflect chronically raised intracranial hypertension. MRI shows an enlarged sella containing material isointense to CSF, in which infundibulum is seen to extend posteriorly to the lower part of the fossa [37].

Trauma: MRI is hampered by clinical difficulty of studying the uncooperative patient and in whom life support equipment is essential. However, MRI is superior to CT in detection and characterization of parenchymal and extra axial haematomas. MRI is therefore used in evaluation of subacute or chronic phase of trauma, rather than the acute phase.

PHYSICS OF MRI

Magnetic resonance imaging is a noninvasive method of mapping the internal structures of the body. It employs radio frequency radiation in the presence of carefully controlled magnetic fields in order to produce high quality cross-sectional images of the body in any plane. MRI does not produce ionizing radiation and appears to be without hazards.

Bloch and Purcell and their colleagues described the phenomenon of MRI independently but almost simultaneously in 1946 and for the discovery they were jointly awarded the Nobel Prize for physics in 1952. The use of MRI for imaging required a method for spatial localization. Lauterbor in 1973 showed that by applying a linearly varying magnetic field to the body, spatial localization could be obtained. Mansfield and Maudsly et al first published first human in vivo images in 1977.

Nuclei suitable for MRI are those, which have an odd number of protons or neutrons and therefore possess a net charge and have angle momentum. These nuclei behave as magnetic dipoles. Hydrogen nucleus is particularly favorable nucleus from the MRI standpoint because of its distribution through out the body. The proton can be regarded as a small suspended bar magnet. When we put them into external magnetic field they align themselves either in the parallel or anti parallel direction.

The direction of the strong magnetic field conventionally defines the Z –axis, which is generally along the longitudinal axis of the patient in a typical MRI imaging machine. Resistive, permanent or super conducting magnets provides the strong magnetic field, which must be homogenous over a volume, large enough to contain the human body in an MRI imaging machine.

Because the nuclei are spinning, they respond to a magnetic couple like a gyroscope and their axes are tilted so that they come to rotate at exactly the same frequency about the magnetic field direction in a movement known as precession. The frequency of precession is directly proportional to the applied magnetic field for protons. This relationship is expressed as the Larmor equation.

$$f=B\gamma$$

f is the resonant frequency, γ is the gyro magnetic ratio and, B is the applied field.

When the external radio frequency pulse and the protons have the same frequency (precession frequency) the protons can pick up some energy from the radio wave a phenomenon called resonance. This has two effects. (1) Longitudinal magnetization decreases. (2) A new transversal magnetization is established. The net magnetization along the Z- axis is deviated through an angle, which depends upon the strength and duration of the pulse of the radio frequency magnetic field.

This rotates the magnetization in the Z direction through either 90^0 or 180^0. After the applied radio frequency pulse is removed, the magnetization returns to its equilibrium position along the Z- axis in an exponential manner and as it does so, the changing magnetization induces a small voltage in a receiver coil. The electrical signal detected following a radio frequency pulse is known as free induction decay.

The first of these relaxation times T1 or the longitudinal relaxation time represents the time taken by the system of nuclei to return to thermal equilibrium after the radio frequency pulse. The second or the transverse relaxation time, T2, indicates the characteristic decay time of the free induction decay and is due to irreversible dephasing of the initially coherent precission of nuclei, which follows the radio frequency pulse.

The principal pulse sequences are (a) partial saturation which typically utilizes a 90^0 radio frequency pulse (b) spin echo which utilizes a 90^0 pulse followed at a time TE/2 by a 180^0 pulse. (c) Inversion recovery, which utilizes a 180 pulse, followed at a time T1 later by a 90^0 pulse.

The contrast in a short TR, short TE sequence is based primarily on differences in T1. They are called T1 Weighted sequences. The tissues with low values on T1 have the highest signal intensity on T1W spin echo sequences (fat and methemoglobin). Images with long TR and TE are regarded as heavily T2 W images. Proton density weighted images are obtained by minimizing the effect of T2 and T1 thus resulting in long TR and short TE values.

In the inversion pulse sequence there is 180-degree pulse followed at a time T1 (inversion time) later by a 90^0 pulse. If T1 is decreased to 100-150 millisecond, it is possible to null the signal from fat with a short T1 inversion recovery STIR sequence. It is also possible to increase T1 in order to null the signal for fluids (the fluid attenuated inversion recovery or FLAIR sequences) this can be used to show subtle lesions of the brain.

The contrast medium commonly used for magnetic resonance imaging is Gadolinium DTPA. It crosses the abnormal blood brain barrier. Gadolinium causes a reduction of T1 and T2, although the absolute effect on T1 is greater than T2. The decrease in T1 increases relative signal intensity, whereas decrease in T2 causes increase in signal intensity. The overall effect is dependent on the concentration of the Gadolinium used and the pulse sequences used.

METHODOLOGY

This was a prospective descriptive study. The study group comprised of patients who had cranial MRI done between 1/1/2003 and 31/12/2003. The examinations were performed using a Siemens Magnetom Open unit, (Erlangen, Germany model number H-SP VB33F, 1996). It is a 0.2 Tesla machine utilizing a resistive magnet (Permanent Open System).

The request form of the patients referred for brain MRI examination was reviewed and patients were counseled accordingly. Patients were requested to fill a consent form and advised to change into the clothes provided. The patients weight was recorded and the patients were taken to the MRI examination room and requested to lie supine on the table. The head coil was adjusted around the patient's skull. They were informed that they will hear some noise during the examination and were instructed not to move during that time.

At the beginning of the examination a localizer was obtained in sagittal, coronal and axial planes with a TR and TE values of 40ms and 10ms respectively. Based on the sagittal localizer different sequences were planned. The routine sequences obtained are axial T1W, axial T2 W, and T2W coronal and axial FLAIR sequences. Further sequences were obtained depending on the findings of these sequences. In conditions where intravenous contrast medium was required, Gadolinium DTPA was given in a dose of 0.2mg/kg body weight. The decision to deviate from the routine protocol is based on clinical information provided by the referring doctor.

For T1W images the TR and TE values are in the range of 450-550ms and 15-26ms respectively. For T2W images the TR and TE values are 4500-5500ms and 95-110 ms respectively. For FLAIR images TR and TE values are in the range of 5000-5500 ms and 91-95ms respectively.

Some special protocols used included:

1) Pituitary examination: T2 axial
   T1 Coronal and Sagittal images (thin section, 3mm)
   Were obtained before and after contrast.
2) Meningitis: Routine and T1 axial with contrast.
3) Metastasis: Routine and T1 axial with contrast.
4) Tumors: Routine and T1 axial with contrast in certain circumstances localized T1 Sagittal and coronal with contrast is done depending on the location of the lesion.
5) Acoustic Neuromas; Routine and T2 thin section coronal through internal auditory meatus; T1 coronal and T1 axial post contrast.
6) Congenital Malformations: Routine plus T1 and T2 Sagittal.
7) Epilepsy: routine plus T2 thin section coronal through hippocampus.

The radiologists at Diagnostic Center interpreted the MRI scans. The details about the signs and symptoms of the patient were obtained from the request form. No histopathological correlation or laboratory report was used in this study. The diagnostic evaluation was confined to the imaging findings.

The data was collected from the request forms of the referring physicians. Data was entered using Excel software and data analysis was done using SPSS software. Results are presented in both frequency and percentages.

Sample size determination:
Fisher's formula was used for sample size computation -

$$n = \frac{Z^2_{1-\alpha/2}\, P\,(1-P)}{d^2}$$

Where, n = sample size to be determined
Z = standard error from the mean corresponding to 95% Confidence level.
P = Proportion of type of cerebral pathology where MRI is most Frequently requested.
d = Absolute precision
α = Level of significance (5%)

Since proportion is unknown, assume P = 50%
2 tailed ($1 - \alpha/2$) = 385 minimum sample.

1 tailed ($1 - \alpha$) = 270 minimum sample

In this study the study sample is 565 patients. A comparative study was done between MRI and CT for 87 patients who had a previous CT scan done. Thus comparison between the two imaging modalities is done only in 87 patients. The comparison is based on the reports of CT scans and MRI scans reports.

The results are represented in the form of tables and graphs.

Representative films are presented in photographs for unique and/classical illustrations.

Limitations of the study:

The accuracy of final diagnosis is based on radiologists report. No patient follow up was undertaken because of time and cost constraints.

Data collection period was restricted to one year, as this time was found sufficient to collect the minimum number of the required cases.

ETHICAL CONSIDERATIONS

The KNH Ethical Committee approved the research protocol.

Approval to conduct the study at Diagnostic Center was obtained.

The patients name will not be used in the study and confidentiality will be maintained.

Consent of the patients was not obtained. The results were handled confidentially and used only for the purpose of this dissertation. In addition, the patients were not subjected to any harmful procedure and were not requested to undergo any further investigation.

RESULTS

565 patients were examined over a period of one year. The maximum numbers of patients were in the age group of 50- 59 (110 patients), followed by age group of 40 – 49 (84 patients), age group of 60-69 (78 patients), 70 plus age group (75 patients), age group of 30-39 years (72 patients), age group of 20-29 years (58 patients), and age group of 10-19 years (50 patients) respectively [ref. H1]. The least number of patients were in the age group of 0 – 9 (28 patients). The male to Female ratio of the patients examined was 1.13: 1.[ref.P1]

The single most common symptom of the patients referred for MRI examination was headache, seen in 157 (27.8%) patients. Headache along with other symptoms (nausea, vomiting, memory loss, visual impairment, vertigo, weakness of limbs and facial muscles, hearing impairment dementia etc) was seen in 283 (51.2%) patients.[ref.T2]
Convulsion was the presenting symptom in 62 (11%) patients, visual impairment was seen in 21 (3.7%) patients, limb weakness and paralysis in 19 (3.4%) patients, loss of memory in 19 (3.4%) patients, Vertigo in 11 (1.9%) patients, facial weakness/palsy was seen in 7 (1.2%) patients and dementia in 6 (1.1%) patients respectively.

In the 565 patients the following conditions were diagnosed. [ref.T1] Normal were diagnosed in 245 (43.3%), nintythree (16.5%) had infarction or ischaemic changes, fortyeight (8.5%) were diagnosed as having tumors, ninteen(3.4%) were diagnosed as demyelinating conditions, sixteen (2.8%) had infection, eight(1.4%) had cerebral bleed, AV malformation was seen in 3 (0.5%) cases and congenital malformation was diagnosed in 2 (0.4%) patients. Nine(1.2%) patients were diagnosed as having Mesial Temporal Sclerosis, 5 (0.8%) patients had Empty Sella Syndrome and 3 (0.5%) patients were diagnosed as having benign intra cranial hypertension and in 37 (6.5%) patients miscellaneous diagnosis was made. [refT17].

In 245 cases no intracranial abnormality was detected and the cases were diagnosed as being normal. This subset thus, constituted the maximum number of cases. The age of the patients varied from 2 months to 78 years, mean age of presentation being 37 years. There were 115 male patients and 126 female patients, giving a male to female ratio of 1: 1.1.[ref.P19]
Among the patients diagnosed as normal, the most common presenting symptom was headache (seen in 60.7% of cases). Headache along with other symptoms like nausea, vomiting, visual abnormalities and sensory symptoms was present in 12.2%, convulsions in 9%, loss of memory in 3.5%, head injury in 3.5%, visual impairment in 3.3%, limb weakness in 3.3%, vertigo in 2.5% and symptoms due to cranial nerves in 1.6% of patients.[refT23]

Ischaemic changes were one of the most frequently diagnosed intra-cranial pathologies, being present in 48 patients (8.5%). The age of patients diagnosed with ischaemic changes ranged from 2 years to 78 years, with a mean of 56 years.[ref H2] The male to female ratio was 3:1[refP2]. Dementia constituted the major presenting symptom, seen in 20 (41%) patients, followed by twitching and numbness around the lips in 8 patients (16%). The regions most frequently involved in ischaemic changes are the peri and para ventricular areas (35%) followed by parietal lobe (31% of cases), temporal lobe (5%), pons (3%) and Occipital lobe (3%) respectively.[refT3]

Infarction was diagnosed in 45 patients (8%). Out of these 12 patients had lacunar infarct. The age of patients diagnosed as having infarction varied from 6 years to 85 years with the mean age of the patients being 62 years[refH3]. The male to female ratio was 1.5.1.[refP3] Infarction was most frequently found in the region of parietal lobe (26%), followed by frontal lobe (13%), Occipital lobe (11%), Temporal lobe (11%), Para ventricular (7.5%), brain stem (7.5%), Basal ganglia (7.5%) and cerebellum (5.5%) respectively.[refT4]

Lacunar infarcts were diagnosed in 12 patients. Age of patients diagnosed as having Lacunar infarction varied from 3 years to 86 years, with the mean age of patients being 65 years.[refH4] The male to female ratio was 5:1[refP4]. Lacunar infarcts are found most frequently in thalamus (25%), followed by basal ganglia region (20%), pons (10%), Midbrain (10%), Internal capsule (10%), Frontal lobe (10%) and Parietal lobe (10%) respectively. [Ref. T5]

Tumors were diagnosed in 48 (8.5%) out of the 565 patients. The age of the patients diagnosed as having tumors ranged from 3 years to 78 years, mean age being 41 years.[refH5] The female patients constituted 48% and male patients constitute 52% of cases giving a male to female ratio of 1.1:1.[refP5] Headache along with other symptoms like limb weakness, hearing loss, vomiting, nerve symptoms, convulsions, gait abnormalities, etc. were the most frequent presentation of cases diagnosed as brain tumors, being present in 50% of the cases.

The various tumors diagnosed along with their frequency is as follows [ref T6]: Glioma was diagnosed in 14 (29%) patients, meningioma in 10 (20.8%) patients, Sella/ suprasellar masses in 9 (18.75%) patients, CPA tumor in 4 (8.3%) patients, metastasis in 3 (6.3%) patients, hemangioma in 1 case. In 3 patients, it was not possible to differentiate between infection, infarction and tumor. In these cases clinical correlation was recommended.

The distribution of tumors was as follows [refT7]:
Frontal and parietal lobes were the most frequently involved areas in 10 patients each (20.8%). Sella/ Suprasellar distribution of the tumor was found in 10 (20.8%) patients, CPA tumors in 5 patients (10.4%), Temporal lobe in 5 patients (10.4%), cerebellum in 2 patients (4.1%) and 1 case each in the region of occipital lobe, brain stem, vault and nasopharyngeal carcinoma extending to the frontal lobe. Multiple lobes were involved in 2 patients.

Gliomas were diagnosed in 14 patients, comprising almost 30% of the tumors. Thus gliomas were the most commonly tumors diagnosed tumors. The age range of gliomas varied from 4 years to 74 years, with the mean age being 38 years.[refH6] The gliomas had male to female ratio of 2:1. [Ref. P6] The common location of the Gliomas was the parietal region (38.5%) followed by frontal region (23.1%). [Ref. T8]

Meningioma was diagnosed in 8 patients. The age distribution varied from 30 years to 72 years, mean age being 45 years [refH7]. Male to Female ratio for meningioma was 1:3[refP7]. 3 cases (33%) of meningiomas were found to be parasaggital, 2 cases (22%) were found to be convexity meningiomas, 2 cases (22%) were found in the posterior fossa (1 attached to the tentorium and 1 to the posterior edge of the petrous bone) 1 each was found in the region of foramen magnum and sphenoid ridge. [refT9]

The tumors diagnosed at the cerebello- pontine angle were as follows [refT10]: Glomus jugulare in 2 patients (33%), acoustic neuromas in 2 patients (33%), meningioma and epidermoid in 1 patient each (16% each).

Among the sellar/ suprasellar tumors the mean age of patients was 42 years [refH8] with the male to female ratio of 2:3[refP8]. Micro adenoma was the most common tumour in the sellar region, seen in 3 patients (30%). Macro adenoma comprised 30%, followed by craniopharyngioma 20%, and meningioma in 10 % and Rathkes cleft cyst in 10% of the cases respectively.[refT11]

Infection was diagnosed in 16 (2.8%) patients. The mean age of patients suffering from infection was 27 years [Ref. H9] with a male to female ratio of 1.6:1[Ref. P9]. Headaches along with other symptoms (fever, nausea, vomiting, photophobia, and convulsions) were the main presenting symptom being present in 45.8% of the patients[ref. T12] The region most frequently involved was the parietal lobe (43.75%) followed by frontal lobe(25%), putamen, centrum semiovale, temporal and occipital lobes (12.5% each) [Ref. T13].

Demyelinating conditions were seen in 19 (3.4%) patients. The age of the patients varied from 1 year to 86 years, mean being 34.5 years [RefH10]. Male constituted 58% and females constituted 42% of patients, with a male to female ratio of 1.3:1[refP10].

8 patients were diagnosed as having intracranial bleed. Mean age of the patients diagnosed with intracranial bleeds was 53 years[ref.H11], having a male to female ratio of 1.8:1[ref.P11] Out of these 6 patients had subacute subdural bleeds, and 1 each had subarachnoid and intracerebellar bleed.[ref.T14]

A-V malformation was seen in 3 (0.5%) patients. All the patients were in the age group of 21-40 years with male to female ratio of 1:2[ref.P12]. All 3 patients had cavernous haemangiomas.

3 cases were diagnosed with congenital malformations. There was one case each of Chiari malformation, Dandy walker malformation and agenesis of corpus callosum.[ref.T15]

There were 65 patients in whom conditions like mesial temporal sclerosis, empty sella syndrome, benign intracranial hypertension and other miscellaneous conditions were diagnosed. [ref.T16] The male to female ratio for these patient was 1.2:1. [ref.P14]

Mesial Temporal sclerosis was seen in 9 (1.2-%) patients. The age of the patients varied from 4 years to 45 years mean age being 32 years [refH13]. Males constituted 66.6% and females constituted 33.3% of cases, giving a male to female ratio of 2:1[ref.P15]. Convulsion was the presenting symptom in 85% of cases and loss of consciousness was seen in 15% of cases.[ref.T18]

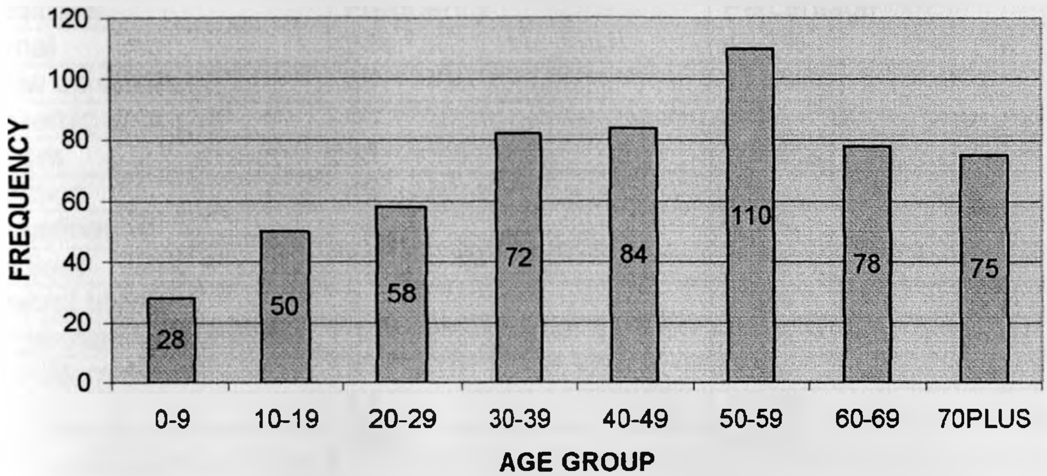
Empty Sella Syndrome was seen in 5 (0.8%) patients. Age of the patients varied from 32 years to 74 years, mean age being 46 years [refH14]. Females constituted 80% and male 20% of patients, giving a male to female ratio of 1:4.[refP16] Headache was seen in 20% of cases, visual impairment in 40% of cases and a combination of these symptoms in 40% of cases.[refT19]

Benign Intracranial Hypertension was diagnosed in 3 patients. The patients were in the age group of 20-35 years [ref. H15]. All the patients were females.[ref.P17]The patients presented with headaches, and in one patient convulsion was the presenting symptom along with headache.[ref.T20]

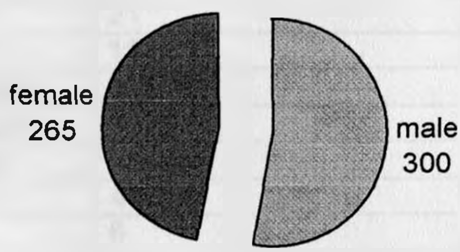
Out of the 565 cases, 65 were for follow-up of the previously diagnosed pathologies. Thirty-one cases were associated with tumors. Of these, 23 cases were postoperative follow-up cases to detect tumor recurrence. The other 8 cases were for tumor follow-up to detect any interval growth [ref. T21].

A comparative study was done between MRI and CT for 87 patients who had a previous CT scan done [ref. T22]. Thus comparison between the two imaging modalities is done only in 87 patients. Out of the 32 patients reported as normal by CT, MRI reported normal in only 18 patients. In the remaining 14 patients MRI showed intracranial pathologies, which were missed on CT scan. This shows that MRI was able to diagnose more lesions than CT.

H1:AGE GROUP DISTRIBUTION FOR THE 565 PATIENTS



P1: Sex distribution of the 565 patients examined



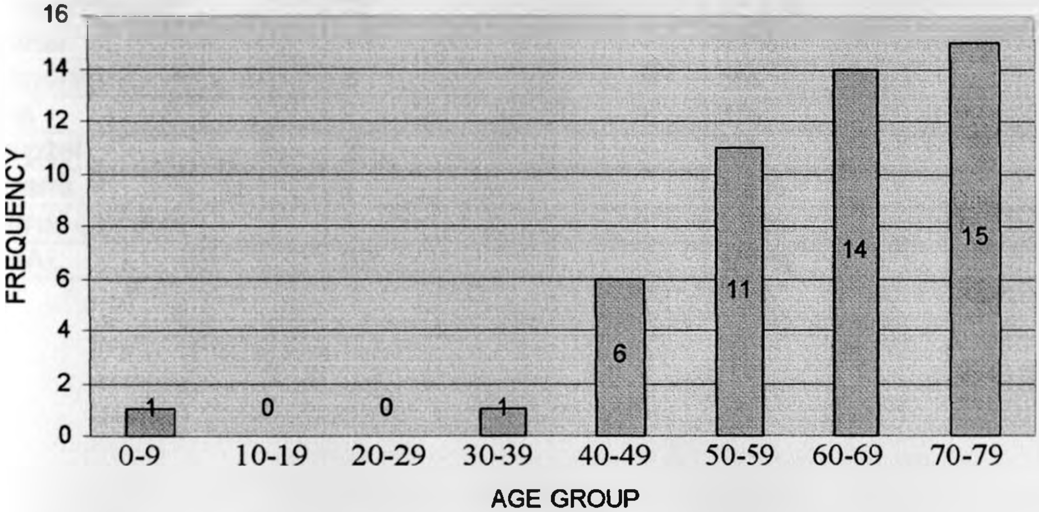
T1: THE CONDITIONS DIAGNOSED IN 565 PATIENTS

Conditions	Frequency	Percentage
Normal	244	43.2%
Follow up cases	65	11.6%
Ischaemic changes	48	8.5%
Tumors	48	8.5%
Infarction	45	8%
Demyelination	19	3.4%
Infections	16	2.8%
Cerebral bleed	9	1.6%
Congenital malformation	3	0.5%
AV malformation	3	0.5%
Others	65	11.5%
Total	565	100%

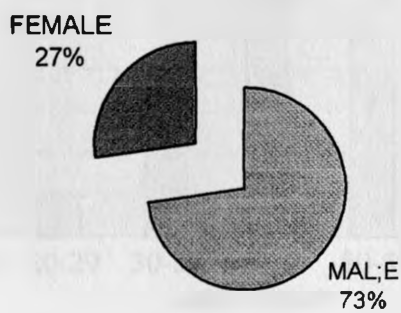
T2: SIGNS AND SYMPTOMS OF 565 PATIENTS

Signs and symptoms	Frequency	Percentage
Headaches	157	27.8%
Convulsions	62	11
Limb weakness and paralysis	19	3.4%
Loss of memory	19	3.4%
Visual impairment	21	3.7%
Vertigo	11	1.9%
Nerve symptoms/palsy	10	1.8%
Facial weakness/palsy	7	1.2%
Head injury/traumas	17	3%
Hearing impairment	4	0.7%
Dementia	6	1.1%
Headache and Other symptoms	283	51.2%
Total	616	100%

H2:
AGE GROUP DISTRIBUTION FOR THE ISCHAEMIC CHANGES



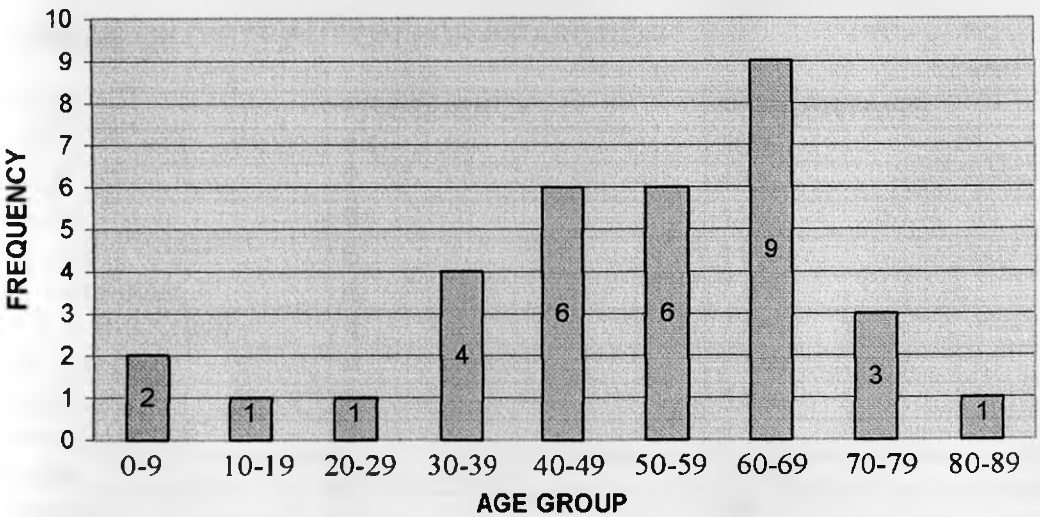
P2: SEX DISTRIBUTION FOR THE ISCHAEMIC CHANGES



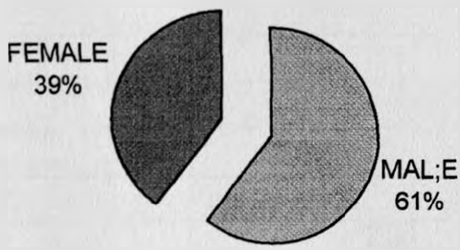
T3: AREA OF DISTRIBUTION FOR ISCHAEMIC CHANGES

AREAS	FREQUENCY	PERCENTAGE
Para ventricular	22	35.5%
Parietal	19	31%
Temporal	3	5%
Pons	2	3%
Occipital	2	3%
Thalami	1	1.5%
Internal Capsule	1	1.5%
TOTAL	62	100%

H3: AGE GROUP DISTRIBUTION OF INFARCTION CASES



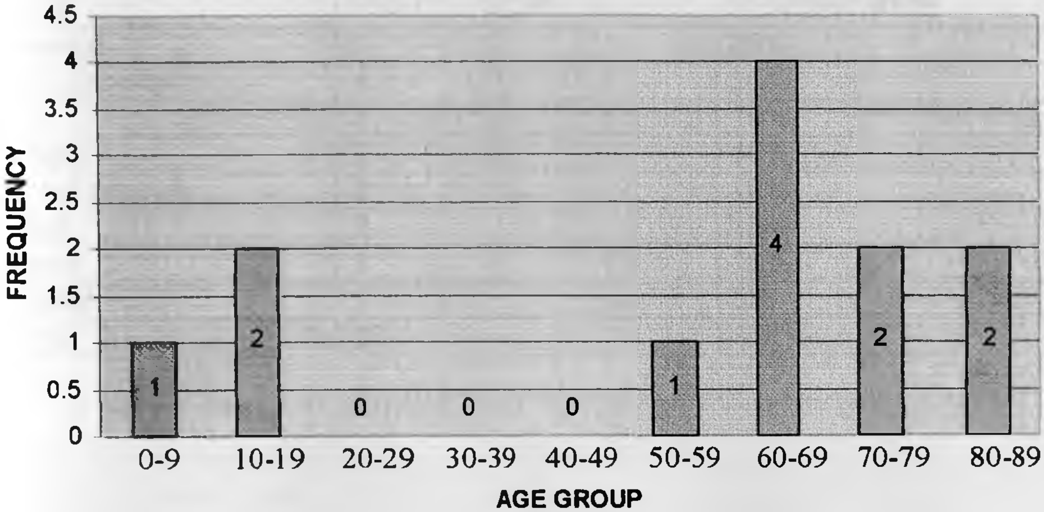
P3: SEX DISTRIBUTION FOR INFARCTION



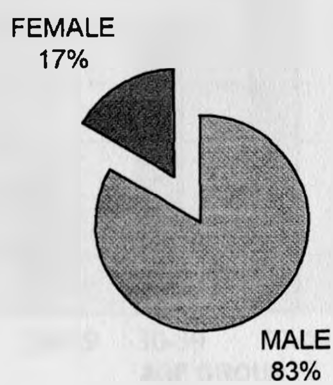
T4: AREAS OF DISTRIBUTION FOR INFARCTION

AREAS	FREQUENCY	PERCENTAGE
Parietal	14	26%
Frontal	7	13%
Occipital	6	11%
Temporal	6	11%
Para ventricular	4	7.5%
PONS & Brainstem	4	7.5%
Basal Ganglia	4	7.5%
Cerebellum	3	5.5%
Intemal Capsule	2	3.7%
Medulla	2	3.7%
Thalamus	1	2%
Mid brain	1	2%
TOTAL	54	100%

H4: AGE GROUP DISTRIBUTION FOR THE LACUNAR INFARCTS



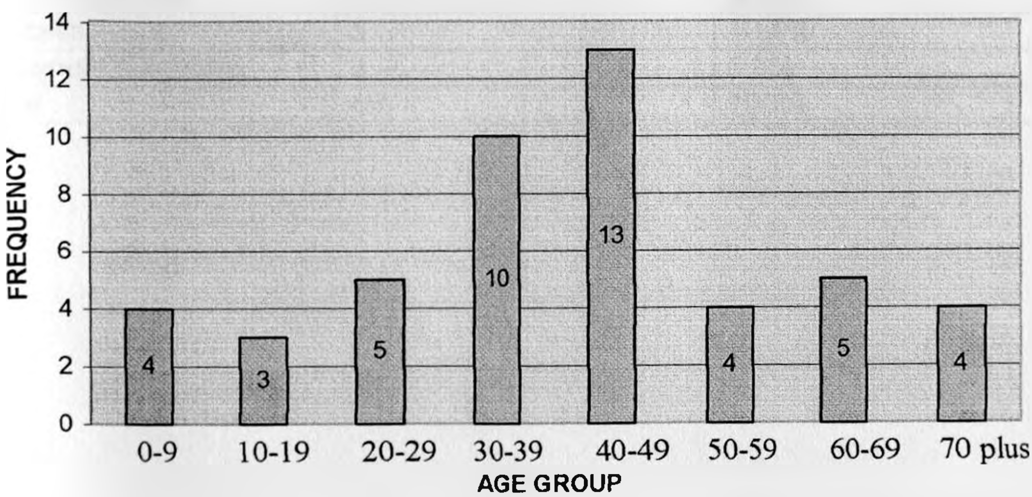
P4: SEX DISTRIBUTION FOR LACUNAR INFARCTS



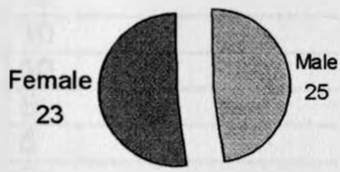
T5: AREA OF DISTRIBUTION FOR LACUNAR INFARCTS

AREAS	FREQUENCY	PERCENTAGE
Thalamus	5	25%
Basal Ganglia	4	20%
Pons	2	10%
Mid brain	2	10%
Internal capsule	2	10%
Frontal	2	10%
Parietal	2	10%
Occipital	1	5%
TOTAL	20	100%

H5: AGE DISTRIBUTION FOR TUMORS



P5: Sex distribution for the Tumour cases



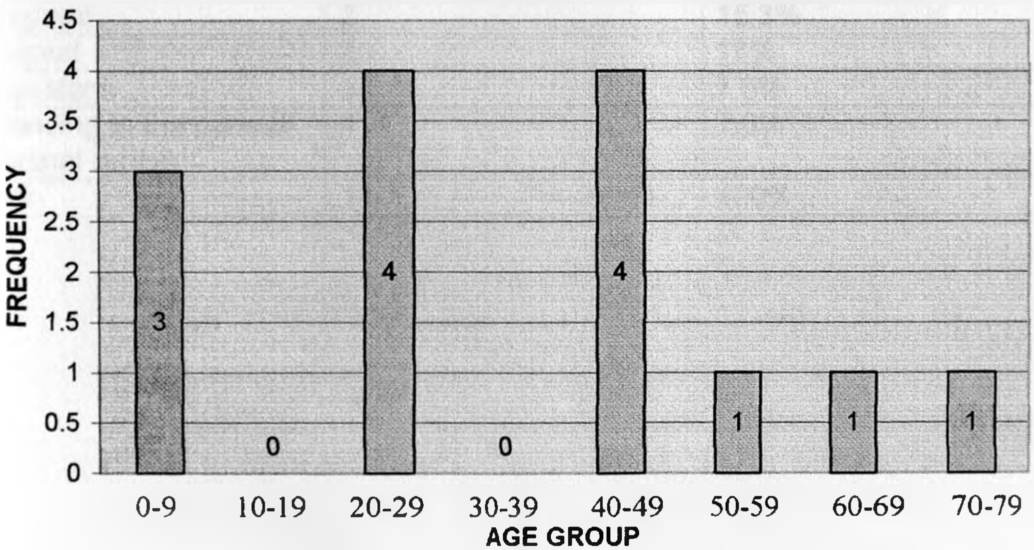
T6: TYPES OF TUMORS

Tumor	No of cases	Percentage
Glioma	14	34.2%
Meningioma	8	16.7%
CPA	5	10.4%
Sella/supra sella masses	10	20.8%
Metastasis	3	6.3%
Haemangiomas	1	2.1%
Miscellaneous	5	10.4%
Uncertain diagnosis	3	6.3%
Total	48	100%

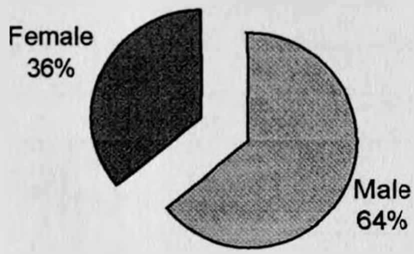
T7: AREA OF DISTRIBUTION FOR TUMORS

Area	Frequency	Percentage
Frontal	10	20.8%
Parietal	10	20.85
Sella/ Suprasellar region	10	20.8%
CPA	5	10.45
Temporal	5	10.4%
Cerebellum	2	4.1%
Occipital	1	2.1%
Brain stem	1	2.1%
Vault	1	2.1%
Naso pharyngeal tumor extending to frontal region	1	2.1%
Multiple	2	4.1%
Total	48	100%

H6: AGE GROUP DISTRIBUTION FOR THE GLIOMAS



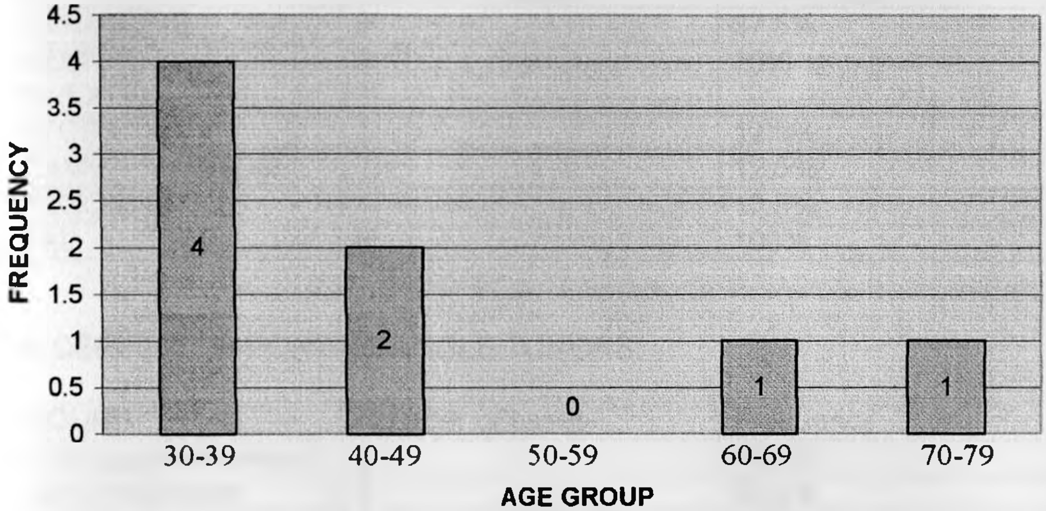
P6: SEX DISTRIBUTION FOR GLIOMAS



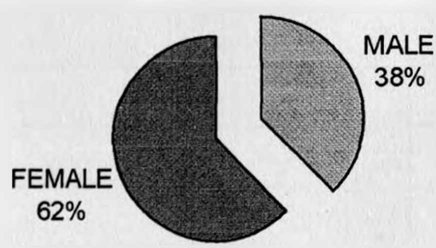
T8: AREAS OF DISTRIBUTION FOR GLIOMAS

Area	Number of cases	Percentage
Parietal region	5	38.45
Frontal	3	23%
Temporal	2	15.3%
Occipital	2	15%
Brain stem	1	7.6%
Extending in the parietal temporal region	1	7.6%
Total	14	100%

H7: AGE GROUP DISTRIBUTION FOR THE MENINGIOMAS CASES



P7:SEX DISTRIBUTION FOR THE MENINGIOMAS CASES



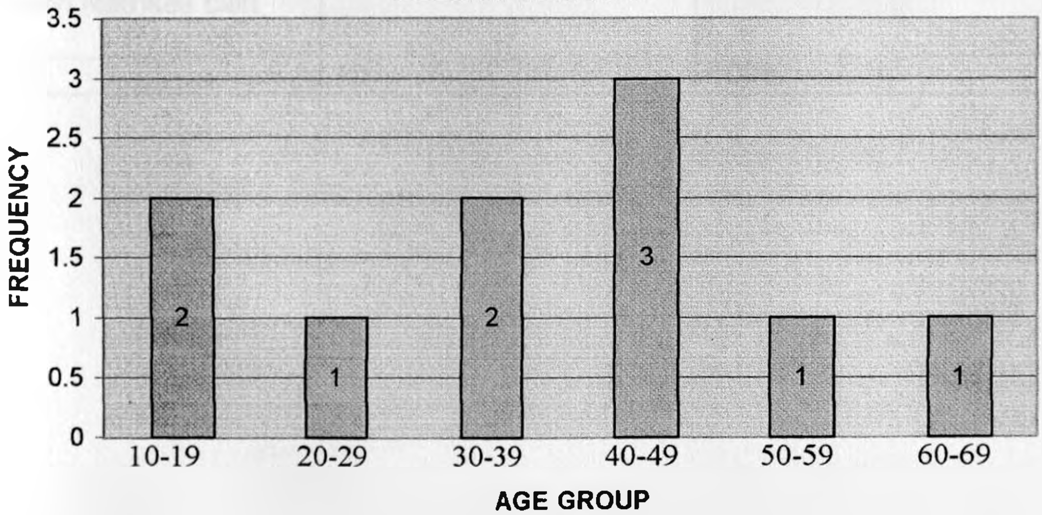
T9: AREA OF DISTRIBUTION OF MENINGIOMAS

Area	Number of cases	Percentage
PARAFALCINE	3	37.5%
CEREBRAL CONVEXITY	2	25%
TENTORIUM	1	12.5%
FORAMEN MAGNUM	1	12.5%
SPHENOID RIDGE	1	12.5%
TOTAL	8	100%

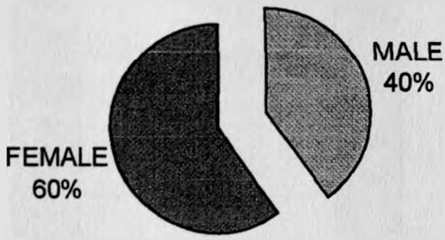
T10: CEREBELLO-PONTINE ANGLE TUMORS:

TUMOURS	Number of cases	Frequency
Gliomas jugulare tumour	2	33.3%
Acoustic neuromas	2	33.3%
Meningioma	1	16.6%
Epidermoid tumour	1	16.6%
Total	6	100%

H8: AGE GROUP DISTIBUTION FOR THE SELLA/SUPRA SELLAR TUMORS



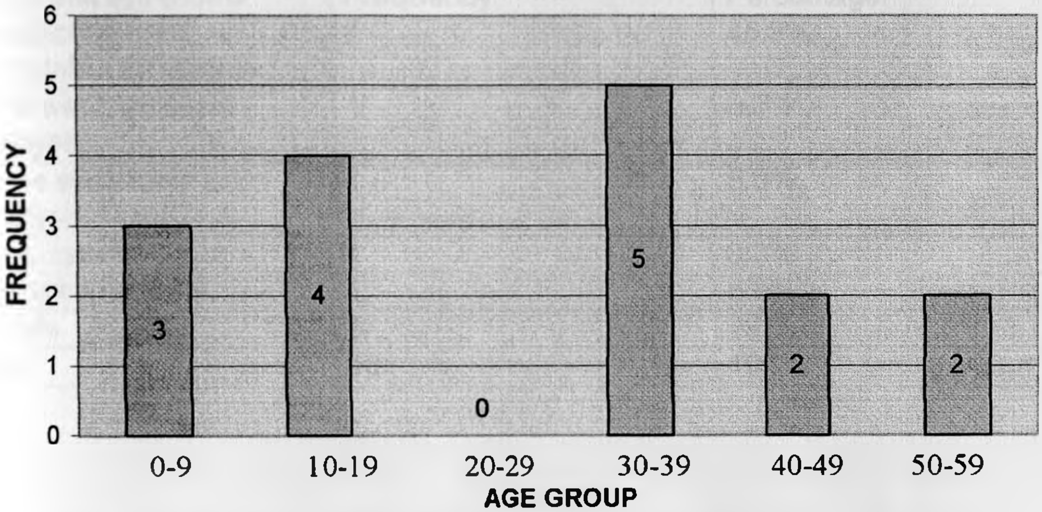
P8: SEX DISTRIBUTION FOR SELLA/SUPRASELLAR TUMORS



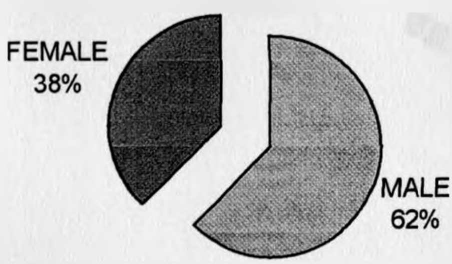
T11: TUMORS IN THE SELLA/SUPRASELLAR REGION

TUMORS	Number of cases	Percentage
Micro adenomas	3	30%
Macro adenomas	3	30%
Cranio pharyngioma	2	20%
Meningioma	1	10%
Could not be established between Rathkes cleft cyst	1	10%
Total	10	100%

H9 AGE GROUP DISTRIBUTION FOR THE INFECTION CASES



P9: SEX DISTRIBUTION FOR THE INFECTION CASES



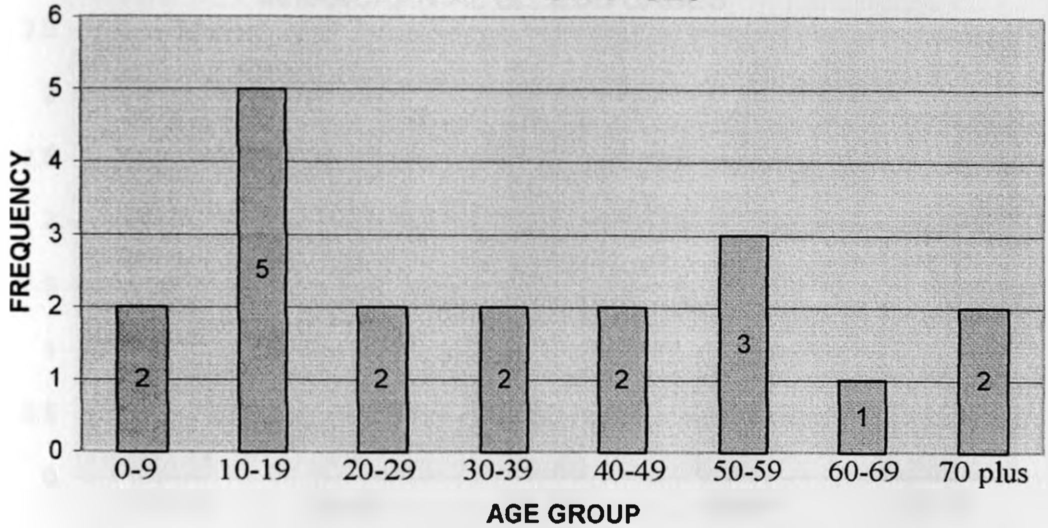
T12: SIGNS AND SYMPTOMS OF PATIENTS WITH INFECTION

Signs and symptoms	Frequency	Percentage
Headaches and associated symptoms	7	45.8%
Limb weakness and paralysis	1	6.3%
Nerve symptoms and paralysis	1	6.3%
Convulsions	1	6.3%
Visual impairment	1	6.3%
Others	5	29 %
Total	16	100%

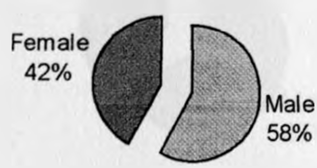
T13: AREA OF DISTRIBUTION OF INFECTIVE LESION

Area	Frequency	Percentage
Parietal lobe	7	43.7%
Frontal Lobe	4	25%
Putamen	2	12.5%
Centrum semi ovale	2	12.5%
Temporal lobe	2	12.5%
Occipital lobe	2	12.5%
Mid brain	1	6.25%
Total	20	100%

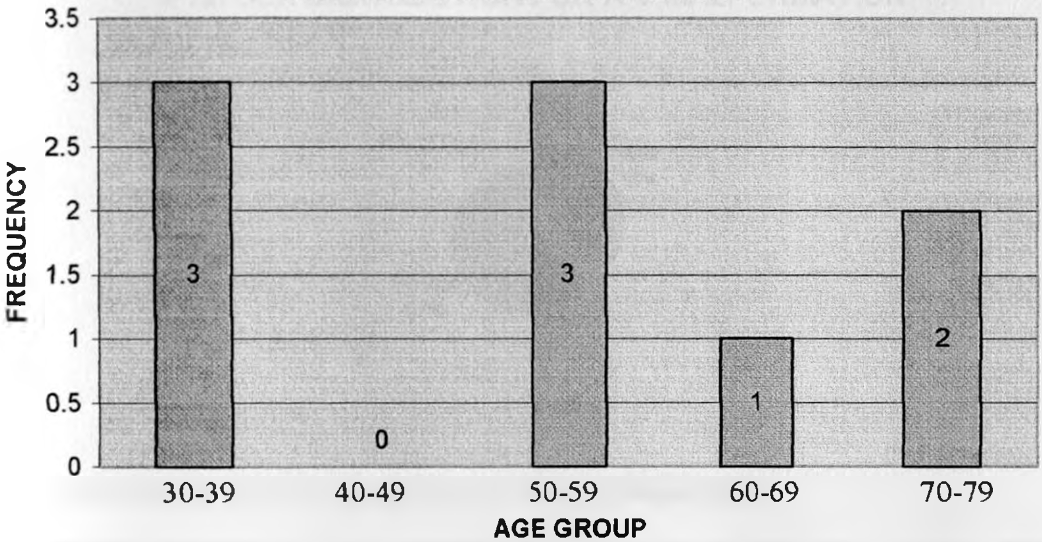
H10: AGE GROUP DISTRIBUTION FOR THE DEMYELINATION CASES



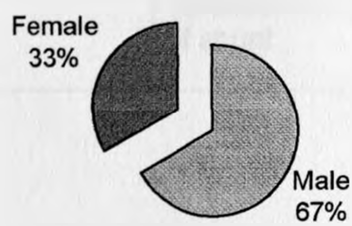
P10: SEX DISTRIBUTION FOR DEMYELINATING CONDITIONS



H11: AGE GROUP DISTRIBUTION FOR THE INTRACRANIAL BLEEDS CASES



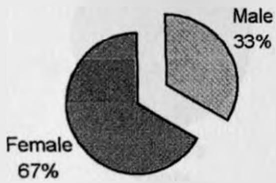
P11: SEX DISTRIBUTION FOR INTRACRANIAL BLEED.



T14: DIFFERENT TYPES OF INTRACRANIAL BLEEDS DIAGNOSED

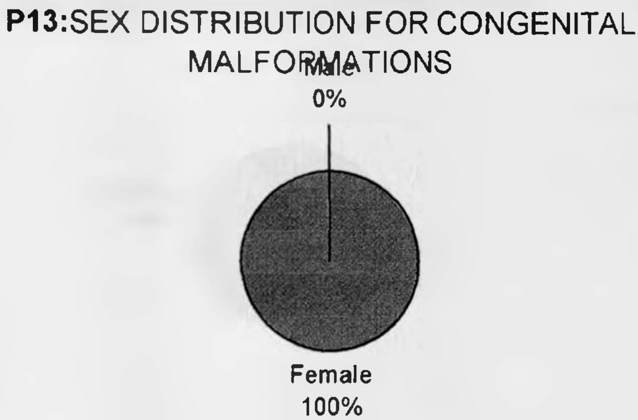
TYPE	FREQUENCY	PERCENTAGE
Subdural Bleed	6	75%
Subarachnoid Bleed	1	12.5%
Intracerebellar Bleed	1	12.5%
Total	8	100%

P12: SEX DISTRIBUTION FOR A-V MALFORMATION

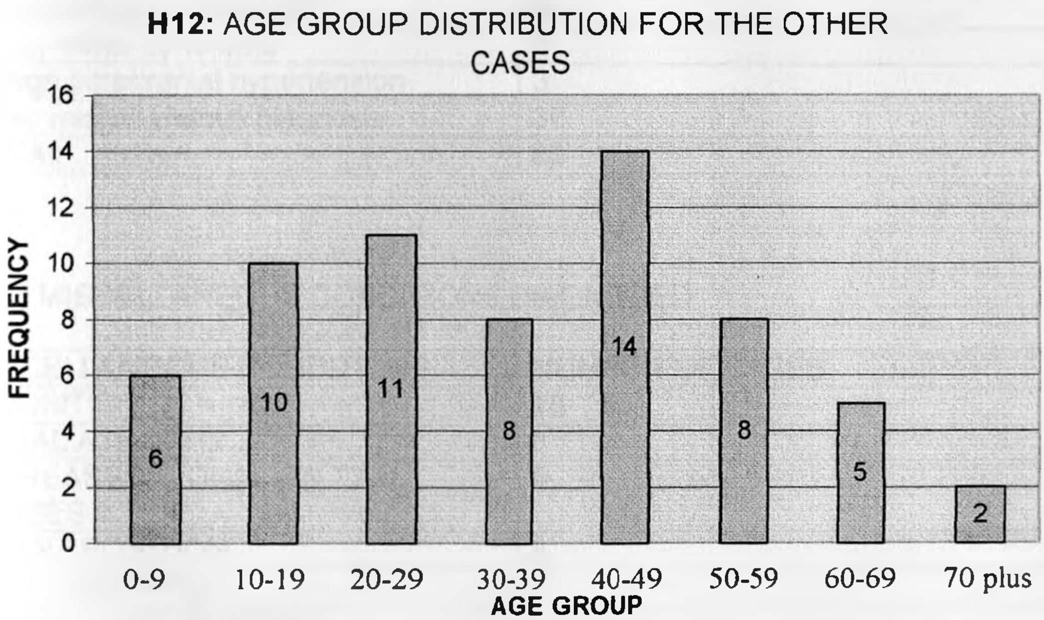


T15: PATIENTS WITH CONGENITAL MALFORMATION

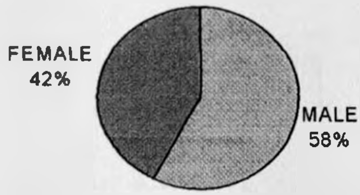
Age	Sex	Symptoms	Diagnosis
39	F	Cerebellar signs	Chairi malformation
6 months	F	Convulsions	Agenesis of corpus callosum
4 month	F	To check the position of shunt	Dandy walker malformation



H 12: AGE GROUP DISTRIBUTION FOR OTHER CASES



P14: SEX DISTRIBUTION FOR OTHERS



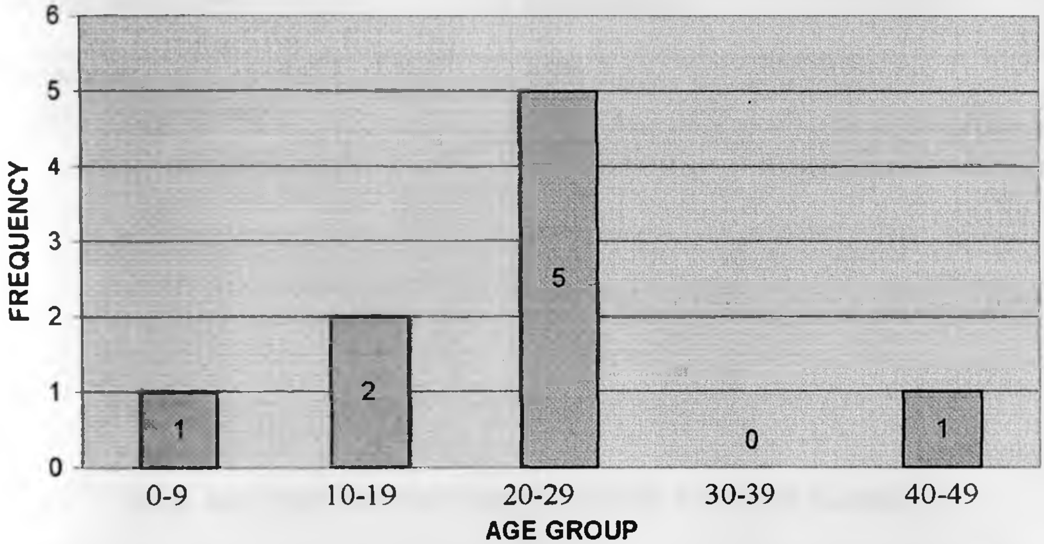
T16: TOTAL NUMBER OF CASES WERE 65

Conditions	Number of cases
Mesial temporal sclerosis	9
Empty sellar syndrome	5
Benign intracranial hypertension	3
Other miscellaneous diagnosis	37
TOTAL	65

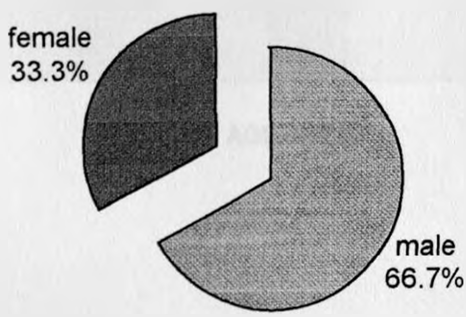
T17: MISCELLANEOUS CONDITIONS DIAGNOSED

MISCELLANEOUS CONDITIONS	NUMBER OF CASES
SINUSITIS	10
FOCAL ATROPHY	8
INCREASED SIGNAL ON T2W IMAGES	5
SHUNT POSITION	4
OPTIC NEURITIS	2
RETINAL; DETACHMENT	1
SUBDURAL HYGROMA	1
ENLARGED PITUTARU	2
BILATERAL TONSILLAR HERNIATION	1
AREA OF GLIOSIS	2
TOTAL	37

H13: AGE GROUP DISTRIBUTION FOR THE MTS CASES



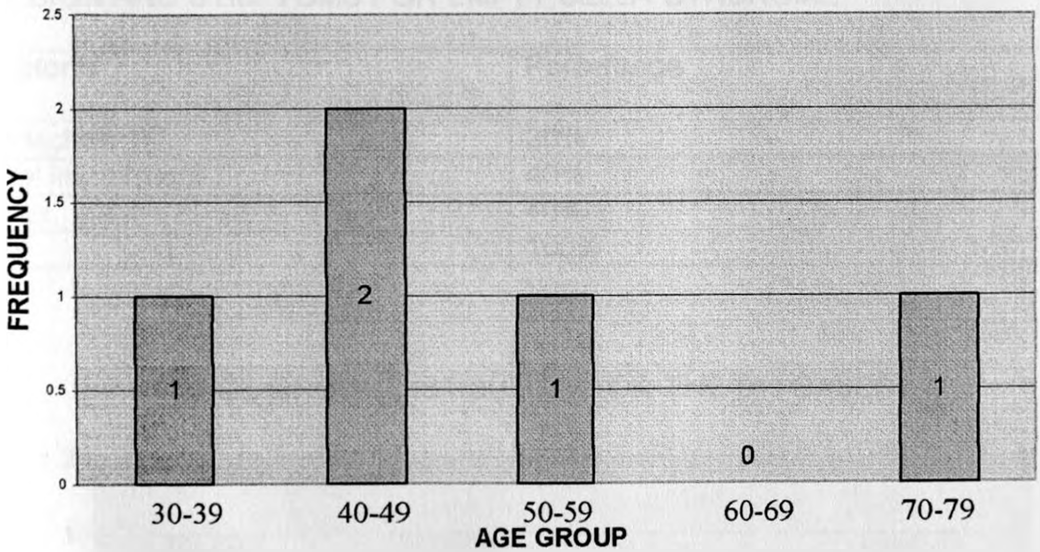
P15: Sex distribution for the Mesial Temporal Sclerosis



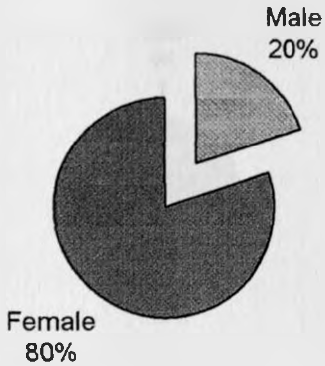
T18: SIGN AND SYMPTOM OF PATIENTS DIAGNOSED WITH MESIAL TEMPORAL SCLEROSIS

Signs and symptoms	Percentage
Convulsions	85%
Loss of consciousness	15%
Total	100%

H14: AGE GROUP DISTIBUTION FOR THE ESS CASES



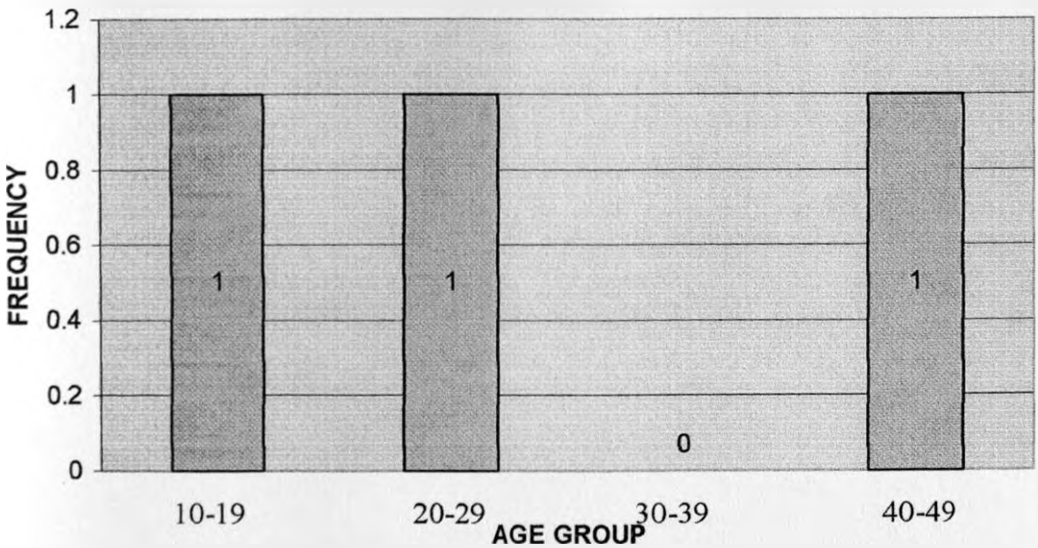
P16: SEX DISTRIBUTION FOE EMPTY SELLA SYNDROME



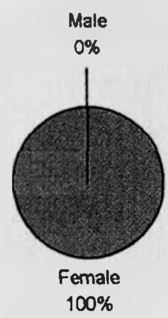
T19: SIGN AND SYMPTOMS FOR EMPTY SELLA SYNDROME

Symptoms	Percentage
Headaches	20%
Visual impairment	40%
Others	40%
Total	100%

H15:AGE GROUP DISTIBUTION FOR THE BIH CASES



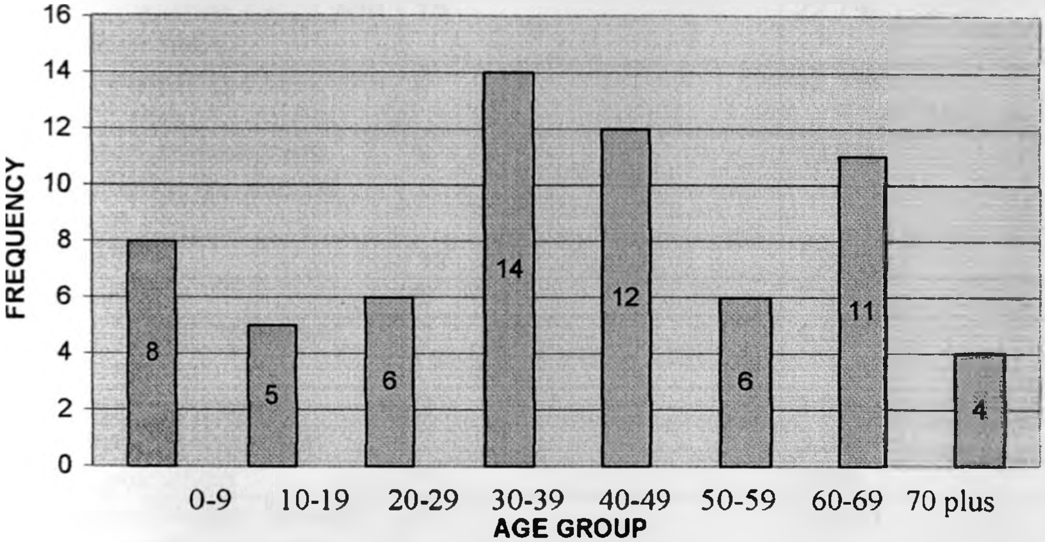
P17: SEX DISTRIBUTION FOR BENIGN INTRACRANIAL HYPERTENSION



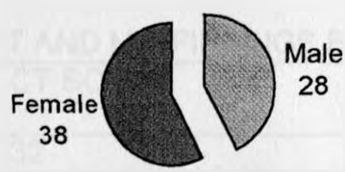
T20: SIGN AND SYMPTOMS OF PATIENTS WITH BENIGN INTRACRANIAL HYPERTENSION

Symptoms	Percentage
Headache	100%
Convulsion	33%

H16: AGE GROUP DISTRIBUTION FOR THE FOLLOW-UP CASES



P18: SEX DISTRIBUTION FOR FOLLOW-UP CASES



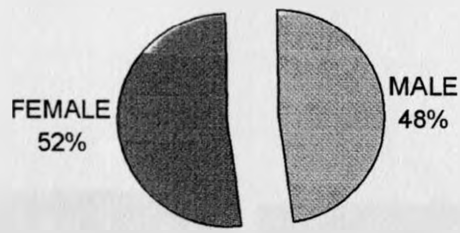
T21: CONDITIONS FOR THE FOLLOW-UP CASES

Conditions	Number Of Patients	Frequency
Post operative cases with no recurrence	15	22.7%
Post operative cases with recurrence	8	12.1%
Tumors (meningioma, lymphoma) for interval growth	9	13.6%
Bleed	11	16.6%
Infection	5	7.5%
Thrombosis of venous sinuses	3	4.5%
Multiple sclerosis	2	3.0%
Ischaemia/Infarction	2	3.0%
Demyelination	1	1.5%
Others (Gliosis, Shunts, Non specific signals)	9	14.8%
Total	65	100%

T22: COMPARISON OF CT AND MRI FINDINGS FOR 87 CASES.

CONDITIONS DIAGNOSED	CT SCAN	MRI
NORMAL	32	18
INFARCTION	9	19
INFECTION	1	5
TUMOURS	16	17
FOLLOW-UP	1	2
INTRACRANIAL BLEED	10	4
DEMYELINATION	-	6
VASCULAR MALFORMATIONS	4	1
OTHERS	8	9
MESIAL TEMPORAL SCLEROSIS	-	6

P19: SEX DISTRIBUTION FOR THE NORMAL CASES



T23: SIGNS AND SYMPTOMS OF NORMAL CASES

Signs and symptoms	Frequency	Percentage
Headache	75	60.7%
Headaches and others	30	12.2%
Convulsions	22	9%
Loss of memory	9	3.7%
Head injury	9	3.7%
Visual impairment	8	3.3%
Vertigo	6	2.5%
Limb weakness & paralysis	8	3.3%
Nerve symptoms	4	1.6%

IMAGES

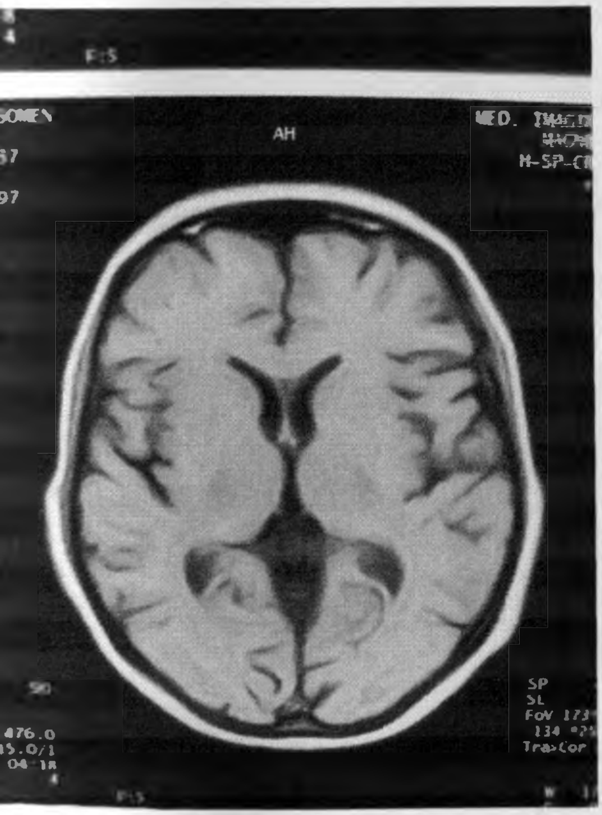


Figure 1: Normal T1W Image

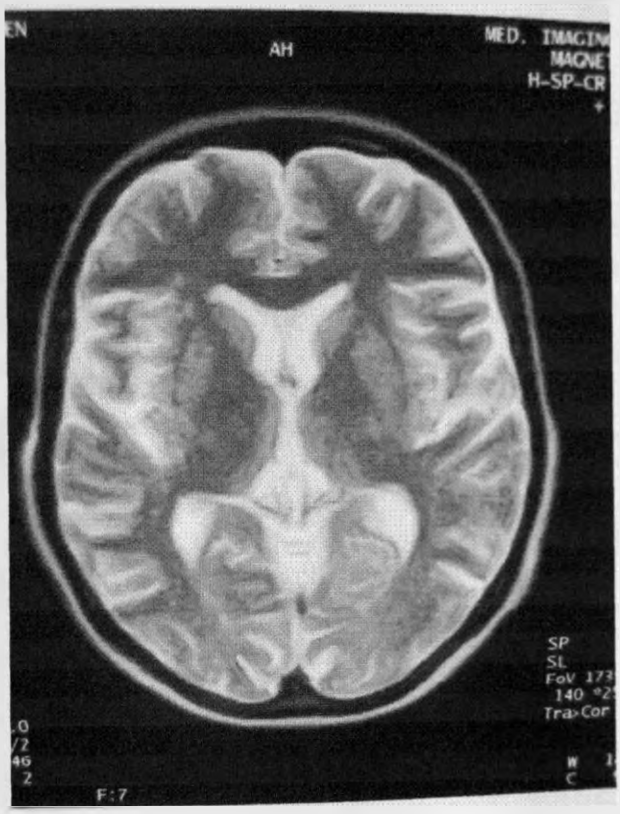
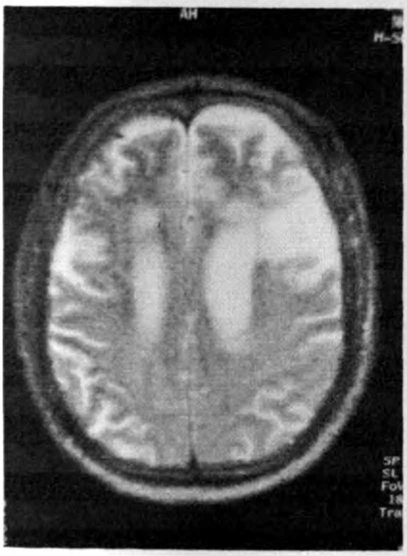


Figure 2: Normal T2W Image



ure 3: Parietal Lobe Infarction

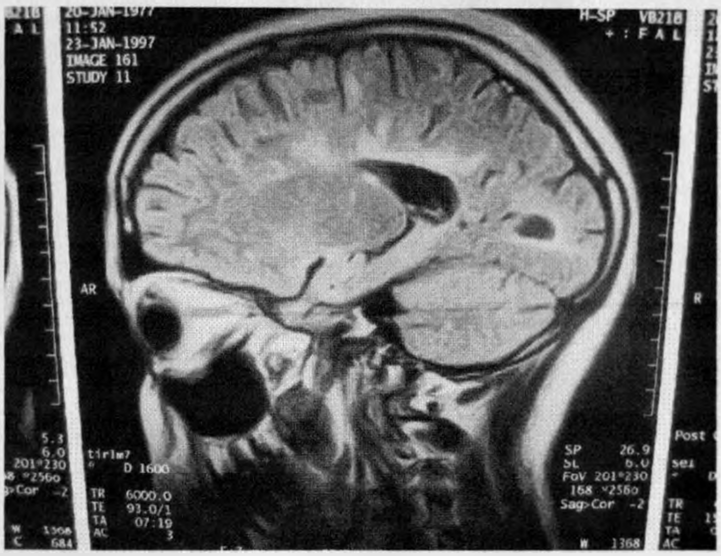
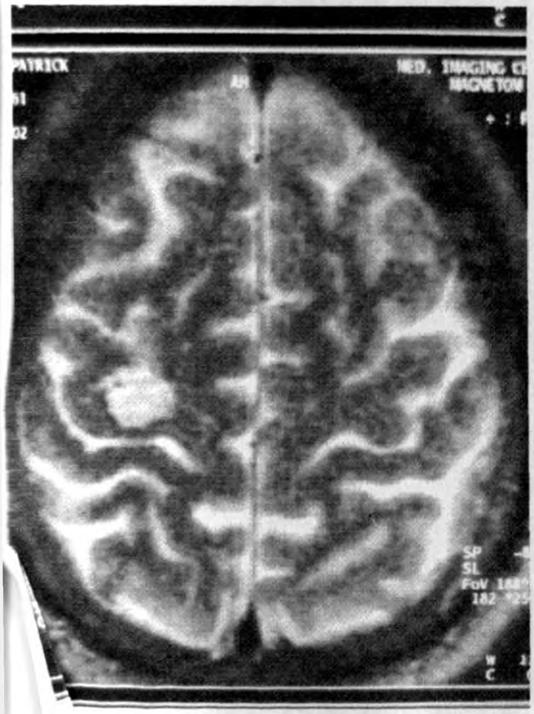


Figure 4: Multiple Sclerosis



F 5: Cavernous Hemangioma

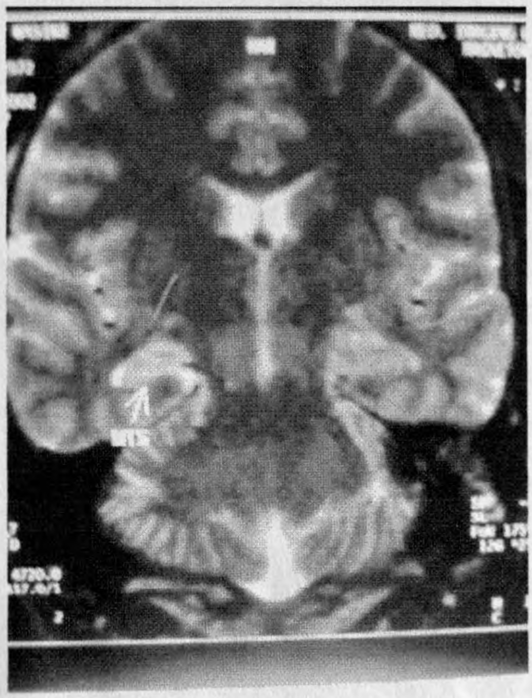


Figure 6: Mesial Temporal Sclerosis

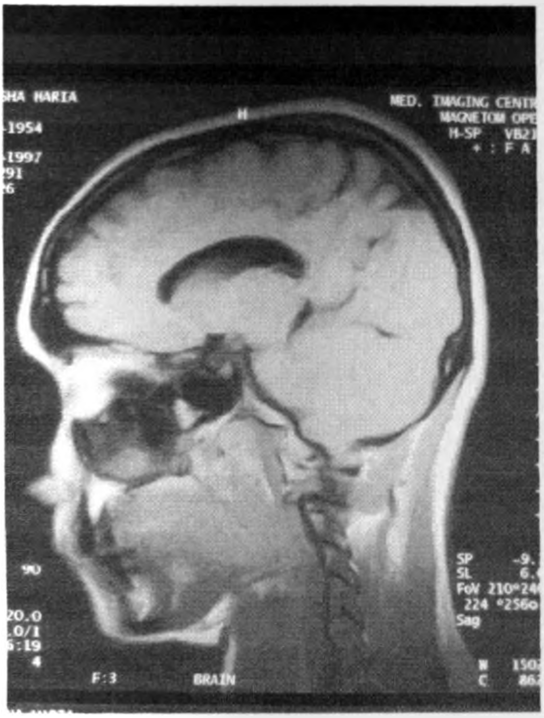


Figure 7: Meningioma T1W

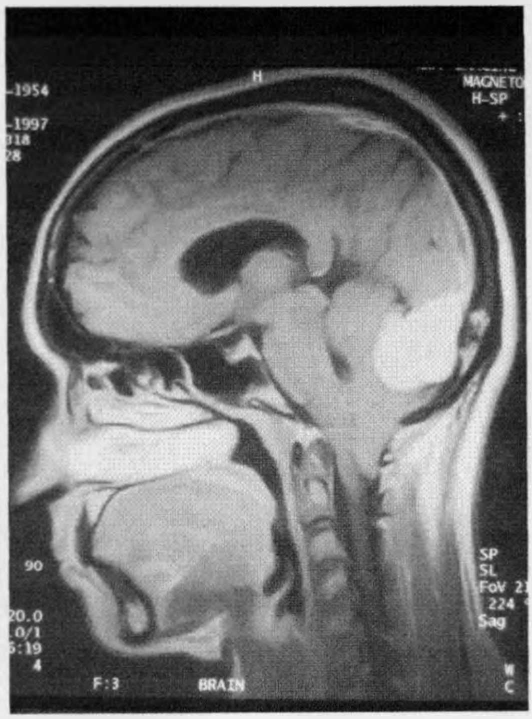


Figure 8: Meningioma Post Contrast

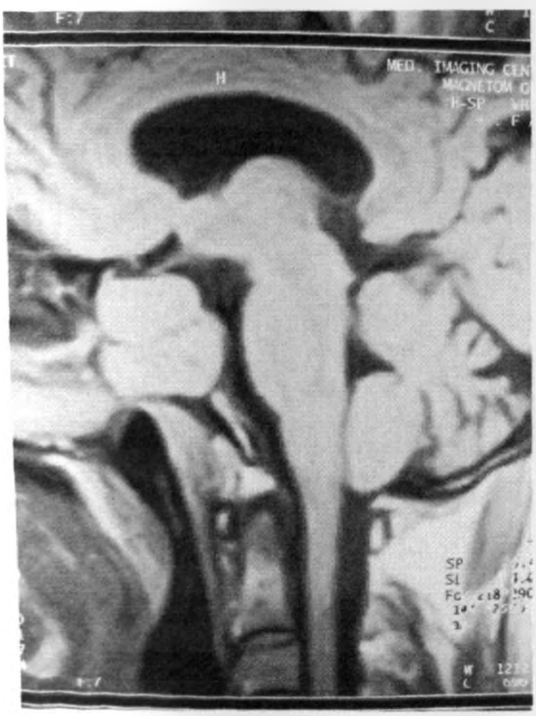


Figure 9: Suprasellar Mass

DISCUSSIONS

The purpose of this study was to determine the pattern of intra-cranial pathologies as seen by MRI technology. A total of 565 patients were analyzed, who were referred to Diagnostic center from various parts of East and Central Africa.

The age of the patients examined by MRI ranged from 2 months to 89 years. This shows the wide range of age group for which MRI is being requested. MRI does not expose the patient to ionizing radiations and therefore, can be used in all age group patients without any adverse affects. Out of 565 patients, 300 (53.1%) were male and 265 (46.9%) were female.

The single most common symptom was headache seen in 157 (27.8%) patients. Headache along with other symptoms (nausea, vomiting, memory loss, visual impairment, vertigo, weakness of limbs and facial muscles, hearing impairment dementia etc) was seen in 283 (51.2%) patients. This reflects that the headaches are the most common symptom of intracranial pathologies.

Headache is a common symptom and may be due to stress, tension or migraine. The "red flags" in the history of the patient with headache are: abrupt onset of new type, very severe headache, progressive worsening of headache over days or weeks, headache precipitated by exertion or associated with fever, nausea or vomiting and neurological symptoms such as numbness or focal weakness. Headaches when accompanied by neurological deficits are a more reliable predictor of intracranial pathologies.

Convulsion was the presenting symptom in 62 (11%) patients, visual impairment was seen in 21 (3.7%) patients, limb weakness and paralysis in 19 (3.4%) patients, loss of memory in 19 (3.4%) patients, Vertigo in 11 (1.9%) patients, facial weakness/palsy was seen in 7 (1.2%) patients and dementia in 6 (1.1%) patients respectively.

Out of a total of 62 patients presenting with convulsions, 22 (35.5%) were normal and 40 (64.5%) patients had some detectable intra cranial pathology. Patients in whom intra cranial abnormalities were detected had neurological deficits along with convulsions. Thus, the presence of neurological deficits along with convulsions is a reliable indicator of underlying intracranial pathology. The pathologies diagnosed in patients presenting with convulsions were tumors in 8(13%) patients, Mesial temporal sclerosis in 7 (11%) patients, demyelination in 5 (8%) patients, infarction in 5 (8%) patients, vasculitis in 3 (5%) patients, A-V malformation in 3 (5%) patients, congenital malformation in 1 (1.6%) patient, Benign intracranial hypertension in 1 (1.6%) patient and in 3 patients non specific increased signals were found.

Dr Ndaihera in his study found that CT could diagnose pathology in 56% of patients presenting with convulsions [54]. In the current study MRI was able to diagnose pathology in patients with convulsions in 64.5% of cases. The common pathologies found by Dr Ndaihera were brain atrophy (20%), tumors (8%), Infection (6%), infarcts (4%) and hydrocephalus (3%). In comparison the current study diagnosed the following abnormalities: tumors (13%), Mesial temporal sclerosis (11%), demyelination (8%), infarction (8%), vasculitis (5%), A-V malformation (5%). This indicates that MRI is a valuable imaging modality for detecting the underlying pathology in-patients presenting with convulsions.

Of the 565 patients, 245 (43.3%)were diagnosed as normal, 93 (16.5%) had infarction or ischaemic changes, 48 (8.5%) were diagnosed as having tumors, 19 (3.4%) were diagnosed as demyelinating conditions, 16 (2.8%) had infection, 8 (1.4%) had cerebral bleed, AV malformation was seen in 3 (0.5%) cases and congenital malformation was diagnosed in 2 (0.4%) patients. 9 (1.2%) patients were diagnosed as having Mesial Temporal Sclerosis, 5 (0.8%) patients had Empty Sella Syndrome and 3 (0.5%) patients were diagnosed as having benign intra cranial hypertension and in 37 (6.5%) patients miscellaneous diagnosis was made. [T35].

Normal

In 245 cases no intracranial abnormality was detected and the cases were diagnosed as being normal. This subset thus, constituted the maximum number of cases. This reflects the high number unnecessary MRIs that are being performed in our local setup. One of the main reasons for this is the inadequate clinical examination performed by the referring physicians, as evidenced by the short and vague history provided on the request form.

The age of the patients varied from 2 months to 78 years, mean age of presentation being 37 years. There were 115 male patients and 126 female patients, giving a male to female ratio of 1: 1.1. This shows the high number of female patients in this group, as compared to the group of patients in whom intracranial pathologies were diagnosed. This could be due to more apprehensive and anxious nature of females as compared to the male patients.

Among the patients diagnosed as normal, the most common presenting symptom was headache (seen in 60.7% of cases). Headache along with other symptoms like nausea, vomiting, visual abnormalities and sensory symptoms was present in 12.2%, convulsions in 9%, loss of memory in 3.5%, head injury in 3.5%, visual impairment in 3.3%, limb weakness in 3.3%, vertigo in 2.5% and symptoms due to cranial nerves in 1.6% of patients. This shows that headache is a common guiding symptom for referrals of MRI. However in the absence of other neurological deficit it is not a reliable indicator of intracranial pathologies. This reflects the need for a thorough clinical examination before referring the patients for MRI.

Ischaemia

Ischaemic changes were one of the most frequently diagnosed intra-cranial pathologies, being present in 48 patients (8.5%). This was consistent with the findings of Katz BH, Quencher et al, who found ischaemia and infarction to be the most frequently diagnosed entity on MRI. (5)

The age of patients diagnosed with ischaemic changes ranged from 2 years to 78 years, with a mean of 56 years. The frequency of ischaemic changes increased with advancing age, the age group of 70-79 years having the maximum number of patients. The ischaemic changes are due to hyaline and thrombotic vasculopathy affecting the arterioles of long penetrating arteries. Thus the changes are more prevalent with advancing age. This is also shown by the current study.

The male to female ratio was 3:1, thus showing a higher male preponderance. This is due to higher risk of atherosclerosis in males as compared to females. Hence there is increased risk of atherosclerosis of cerebral vessels and cerebral ischaemic changes in males.

Dementia constituted the major presenting symptom, seen in 20 (41%) patients, followed by twitching and numbness around the lips in 8 patients (16%).

The regions most frequently involved in ischaemic changes are the peri and para ventricular areas (35%) followed by parietal lobe (31% of cases), temporal lobe (5%), pons (3%) and Occipital lobe (3%) respectively. Due to early involvement of arterioles of long penetrating arteries ischaemic changes are found predominantly in the periventricular white matter, centrum semiovale, basal ganglia and ventral part of pons. The current study has similar findings.

Ischaemic changes were characterized by increased signals on T2W images and FLAIR sequences. The pathophysiology of ischaemic changes is the small vessel thrombotic changes. This results in accumulation of water in the cells and eventually damage of the cell wall. Damaged cell wall permits leakage of intracellular fluid and proteins into the extracellular space causing edema. This causes prolongation of both T1 and T2 time, thus resulting in increased signal on T2W images.

Infarction

Infarction was diagnosed in 45 patients (8%). Out of these 12 patients had lacunar infarct. The age of patients diagnosed as having infarction varied from 6 years to 85 years with the mean age of the patients being 62 years. The male to female ratio was 1.5.1. Infarction results from the atherosclerotic or embolic occlusion of the cerebral blood flow. Thus, infarcts are found more frequently in elderly and in males.

Infarction was most frequently found in the region of parietal lobe (26%), followed by frontal lobe (13%), Occipital lobe (11%), Temporal lobe (11%), Para ventricular (7.5%), brain stem (7.5%), Basal ganglia (7.5%) and cerebellum (5.5%) respectively. Most infarcts are found in the anterior circulation especially in the territory of the middle cerebral artery. This is consistent with the findings of the current study.

Lacunar infarcts were diagnosed in 12 patients. Age of patients diagnosed as having lacunar infarction varied from 3 years to 86 years, with the mean age of patients being 65 years. The male to female ratio was 5:1. Lacunar infarcts are found most frequently in thalamus (25%), followed by basal ganglia region (20%), pons (10%), Midbrain (10%), Internal capsule (10%), Frontal lobe (10%) and Parietal lobe (10%) respectively. Lacunar infarcts result from the hyaline degeneration and thrombosis of perforating vessels. It is found with increasing frequency with advancing age and in diabetics. This is consistent with the findings of the current study.

Acute infarctions are seen as areas of decreased signal intensity on T1W images and increased signal on T2W and FLAIR sequences. Acute infarcts were found to be associated with edema and mass effect, when large in size. Catherine M Mills, Laurence E Crooks et al also found that the ischaemia prolonged the T1 and T2 relaxation time (High signal on T2 W images and low signal on T1W images). [38]

Chronic infarcts were characterized by increased signal on T2W images. They are associated with areas of gliosis, encephalomalacia and surrounding brain atrophy [25] Bonny D, William G Bradley et al found that acute and sub acute infarctions are characterized by sharply marginated areas of high intensity on T2 weighted images. They found in chronic infarcts there was a central zone of low intensity surrounded by a peripheral area of higher intensity. [39].

FLAIR sequences are especially useful for differentiating between acute and chronic infarcts. Acute infarcts were found to be associated with increased signal on FLAIR sequences due to surrounding edema. Chronic infarcts characteristically have reduced signal on FLAIR sequences, if associated with encephalomalacia.

Acute and chronic infarcts can be differentiated on the basis of the changes in the surrounding brain parenchyma. Acute infarcts cause edema and mass effect as opposed to chronic infarct, which result in atrophy.

Tumors:

Tumors were diagnosed in 48 (8.5%) out of the 565 patients. The age of the patients diagnosed as having tumors ranged from 3 years to 78 years, mean age being 41 years. The female patients constituted 48% and male patients constitute 52% of cases giving a male to female ratio of 1.1:1.

Headache along with other symptoms like limb weakness, hearing loss, vomiting, nerve symptoms, convulsions, gait abnormalities, etc. were the most frequent presentation of cases diagnosed as brain tumors, being present in 50% of the cases. Dr. Kibaya in his study, found headache to be the commonest symptom of intra-cranial masses (67.5% of cases), followed by locomotor dysfunction (57.7% of cases). [40].

The various tumors diagnosed along with their frequency is as follows:

Glioma was diagnosed in 14 (29%) patients, meningioma in 10 (20.8%) patients, Sella/ suprasellar masses in 9 (18.75%) patients, CPA tumor in 4 (8.3%) patients, metastasis in 3 (6.3%) patients, hemangioma in 1 case. In 3 patients, it was not possible to differentiate between infection, infarction and tumor. In these cases clinical correlation was recommended.

These findings correlate with the findings of Dr Kibaya [40] who in his study found Glioma to be the most common tumor (36.8%) followed by meningioma (21%) and medulloblastoma (8.7%) respectively.[40]

The distribution of tumors were as follows:
Frontal and parietal lobes were the most frequently involved areas in 10 patients each (20.8%). Sella/ Suprasellar distribution of the tumor was found in 10 (20.8%) patients, CPA tumors in 5 patients (10.4%), Temporal lobe in 5 patients (10.4%), cerebellum in 2 patients (4.1%) and 1 case each in the region of occipital lobe, brain stem, vault and nasopharyngeal carcinoma extending to the frontal lobe. Multiple lobes were involved in 2 patients. This shows that frontal and parietal lobe together constituted almost 50% of the regions that were involved by the tumors.

Gliomas:
Gliomas were diagnosed in 14 patients, comprising almost 30% of the tumors. Thus gliomas were the most commonly tumors diagnosed tumors. The age range of gliomas varied from 4 years to 74 years, with the mean age being 38 years. The gliomas had male to female ratio of 2:1. The common location of the Gliomas was the parietal region (38.5%) followed by frontal region (23.1%). Dr Kibaya, in his study found Gliomas to be most frequently distributed in the parietal region (35%of cases), followed by frontal and occipital region (7.4%) respectively. [40].
This agrees with the findings of the current study.
Gliomas showed decreased signal on T1W images and increased signal on T2W images with varying pattern of enhancement post IV contrast. The majority of Glioma had minimal enhancement thus making them low grade Glioma. Similar findings were seen by Catherine Mills et al, who in their study of 8 Gliomas found, that 5 showed prolongation of T1 (low signal on T1W images). All the Gliomas had prolonged T2 times (high signal on T2W images) in their study. [38].

Most gliomas are recognized either due to the mass effect and or due to signal alteration. The pathological feature that affects the appearance of gliomas on MRI is the increased water content of the tumor. This is particularly marked in high-grade gliomas. Increased water causes prolongation of both T1 and T2 relaxation time resulting in increased signal on T2W images and low signal on T1W images. The contrast enhancement varies with severity of disruption of blood brain barrier. In low-grade gliomas the blood brain barrier is minimally affected, so the enhancement is usually minimal or absent. In contrast, higher grades of gliomas cause moderate to severe disruption of blood brain barrier resulting in contrast enhancement.

Meningiomas:
Meningiomas were diagnosed in 8 patients. The age distribution varied from 30 years to 72 years, mean age being 45 years. Male to Female ratio for meningioma was 1:3. This shows that meningiomas have higher female preponderance.

Three cases (33%) of meningiomas were found to be parasaggital, 2 cases (22%) were found to be convexity meningiomas, 2 cases (22%) were found in the posterior fossa (1 attached to the tentorium and 1 to the posterior edge of the petrous bone) 1 each was found in the region of foramen magnum and sphenoid ridge. This is due to the fact that meningiomas are derived from the arachnoid granulation cells and are extra-axial tumors. Thus, meningiomas appear as masses with a broad base toward the dura.
Dr Imalingat in his study found that meningiomas have increased female preponderance and that the cerebral convexity meningiomas are the most frequent. This correlated with the findings of the present study. [41].
Meningioma distribution as per Anne Osborn is- parasaggital in 25%, convexity in 20%, sphenoid ridge in 15%-20%, olfactory groove 5-10%, pars sellar in 5-10%, posterior fossa in 10%. [42]. Similar findings were found in this study.

On T1W images meningioma were found to be isointense in 66% of cases and hypo intense in 33% of cases. On T2W images meningioma were found to be isointense in 60% of cases and hyper intense in 40%. Thus most of the tumors are isointense to the brain on both T1W and T2W images. Intense enhancement was seen in all the cases. This is due to the extreme vascularity of these tumors. Since meningiomas are isointense to brain on both the T1W and T2W images the lesions may be missed if contrast is not given. Due to the intense contrast enhancement shown by these tumors even the small tumors showed up on post contrast images. Calcification was seen in 3 out of 9 cases, that is 33% of the patients.
According to Allen D Elster, V.Challa et al T1W images are not particularly useful in discriminating pathological subtypes as most tumors were iso intense or hypo intense to cortex regardless of histological subtype. According to them T2W images strongly correlated with histopathological pattern in 75% cases. Meningiomas markedly hypo intense to cortex on T2W images were composed predominantly of fibroblastic or transitional elements, while markedly hyper intense meningiomas demonstrated predominance of syncytial or angioblastic elements. [14].

Sella/Suprasellar masses
Among the sellar/ suprasellar tumors, micro adenoma was the most common tumour in the sellar region, seen in 3 patients (30%). Macro adenoma comprised 30%, followed by cranio pharyngioma 20%, and meningioma in 10 % and Rathkes cleft cyst in 10% of the cases respectively. Pituitary adenomas are the most common neoplasms in the sellar region. This agrees with the findings of the current study, Pituitary adenomas are classified as miroadenomas (<1cm) or macroadenomas(>1cm) based on the size of the tumors.

Microadenomas were confined to the sella and did not cause any enlargement of the pituitary fossa (due to small size of the tumor). They showed low signal on post IV contrast T1W images as compared to the rest of the gland, which enhances prominently. 1 case out of the 3 showed delayed contrast enhancement. This finding was similar to that of Wallace W, Williams P Dillion who found that a focal glandular hypo intensity (low signal) was the most sensitive predictor of adenoma [16].
Macroadenomas characteristically caused enlargement of sella with suprasellar extension (This was due to large size of the adenomas). They showed increased signal on T2W images and were iso intense on T1W images with marked contrast enhancement. Due to their large size and contrast enhancement macroadenomas are easier to diagnose than microadenomas.

Cranio pharyngioma were diagnosed in 2 patients. One was a 16 year old male patient, presenting with seizures, headache and vomiting. The other patient was a 15 years female patient presenting with headaches and vomiting.
Craniopharyngiomas are seen as a mass in the region of the hypothalamus (supra sellar region), iso intense on T1W images with heterogeneous signal on T2W images. Some areas showed decreased signals due to cystic change and calcification. The enhancement was mild and inhomogeneous as most tumors cause minimal disruption of blood brain barrier.

Cerebello-pontine angle tumor:
The tumors diagnosed at the cerebello- pontine angle were as follows:
Glomus jugulare in 2 patients (33%), acoustic neuromas in 2 patients (33%), meningioma and epidermoid in 1 patient each (16% each).
Acoustic neuromas arise most frequently from the vestibular portion of the cochlear nerve [17]. Acoustic neuromas were seen as a mass in the cerebello-pontine angle. They were isointense on T1W and heterogeneously hyper intense on T2 W sequences, and showed intense contrast enhancement. .
Walter L, Robert E et al in their study of MRI imaging in the diagnosis of acoustic neuromas found MRI to be very accurate for demonstration of large and small acoustic neuromas as well as excluding this diagnosis by demonstrating normal seventh and eighth nerve. [43] In another study Victor W, William Bradley et al found that MRI was able to diagnose all of the 25 surgically proven cases, where as CT missed the diagnosis in 6 cases. They concluded that MRI could replace all high resolution CT for diagnosis of acoustic neuromas. [44]
Glomas jugulare tumors arise from the baro and chemo receptors of great vessels. They were seen in the region of cerebello-pontine angle as masses of intermediate density on T1 and T2W images with prominent contrast enhancement. They caused erosion of the temporal bone. Due to extreme vascularity, the tumors show sepenginous areas of flow void due to hugely dilated vessels. However, the current study did not show similar findings.

Infection:

Infection was diagnosed in 16 (2.8%) patients. The mean age of patients suffering from infection was 27 years with a male to female ratio of 1.6:1. Headaches along with other symptoms (fever, nausea, vomiting, photophobia, and convulsions) were the main presenting symptom being present in 45.8% of the patients. The region most frequently involved was the parietal lobe (43.75%) followed by frontal lobe(25%), putamen, centrum semiovale, temporal and occipital lobes (12.5% each). Thus the lesions were seen distributed mainly in the vascular territory of the middle cerebral artery. This can be explained by the fact that the middle cerebral artery supplies the large area of brain parenchyma.

Infective lesions were characterized by low signal on T1W and high signal on T2W images, with post contrast enhancement. This is due to increased water content in the infected areas resulting in prolongation of both T1 and T2 time. This results in increased signal on T2W images and decreased signal on T1W images. Invasion of the brain parenchyma by micro-organisms or due to the effect of the toxin, the blood brain barrier is disrupted. This results in post contrast enhancement seen in these lesions.

Demyelinating conditions:

Demyelination results from breakdown of initially normal myelin. Demyelinating conditions were seen in 19 (3.4%) patients. The age of the patients varied from 1 year to 86 years, mean being 34.5 years. Male constituted 58% and females constituted 42% of patients, with a male to female ratio of 1.3:1. Demyelination occurs in primary toxic damage to the brain, ischaemia, secondary wallerian degeneration and in conditions like multiple sclerosis.

The lesions are characterized by increased signal on T2W and FLAIR sequences.

There were 2 known cases of multiple sclerosis for follow up. One patient showed increase in size of the existing lesions and development of new lesions relative to the previous scans. In the other patient no new lesions were seen and the previous lesions were stable. MRI is especially valuable in diagnosis and follow up of the patients with multiple sclerosis. In acute multiple sclerosis the lesions are larger and show contrast enhancement as opposed to chronic lesions, which are smaller and lack contrast enhancement.

According to John Stevens et al MRI is ten times more sensitive than CT at detecting lesions of multiple sclerosis. They found MRI to be highly sensitive in detecting lesions of multiple sclerosis, and in diagnosing new lesions in previously diagnosed cases, and in providing prognostic information. [45]

Intracranial bleed:

8 patients were diagnosed as having intracranial bleed. Mean age of the patients diagnosed with intracranial bleeds was 53 years, having a male to female ratio of 1.8:1. Out of these 6 patients had subacute subdural bleeds, and 1 each had subarachnoid and intracerebellar bleed.

Sub acute subdural bleed showed high signals on both T1W and T2W images in 5 patients with 1 patient showing a hypo intense rim on T1W images and mixed intensity on T2W images.

The signal changes on MRI depend on the product of degeneration of haemoglobin at the time of imaging. Methaemoglobin formed during the subacute phase results in increased signal on T1W and T2W sequences. However, the deoxyhaemoglobin that is formed during the acute phase of bleeding results in decreased signal on T1W and T2W sequences. The most commonly involved region for subdural bleed was fronto-parietal (4 cases) and, 1 each in the region of temporal and occipital lobe.
Jorman T, Sipponen, Raimo E.Sepponen et al in their study of 5 cases of subdural bleed found bright signal on T1 (reflecting short T1 relaxation time) and high signal on T2W images (long T2 relaxation time). They found MRI to be superior to CT in detection of 2 cases in which the subdural bleed was isodense on CT and present bilaterally and hence was not diagnosed by CT scan [(46).]

Subarachnoid bleed was seen as increased signal on FLAIR in the basal cisterns and in the 4^{th} ventricle. In one patient, intracerebellar bleed was seen behind the 4^{th} ventricle, seen as increased signal on T1W and T2W images. However no underlying cause of the bleed was detected. In a study by William G Bradley on the effect of methemoglobin formation on MRI appearance of sub arachnoidal hemorrhage, they found the iron in methemoglobin is paramagnetic and facilitates T1 relaxation accounting for increasing intensity of sub arachnoid hemorrhage over a period of time. [(47).]

Mesial temporal sclerosis:
Mesial Temporal sclerosis was diagnosed in 9 (1.2-%) patients. The age of the patients varied from 4 years to 45 years mean age being 32 years. Males constituted 66.6% and females constituted 33.3% of cases, giving a male to female ratio of 2:1. Convulsion was the presenting symptom in 85% of cases and loss of consciousness was seen in 15% of cases.
Mesial temporal sclerosis results from prior insult to the growing brain. This results in fibrosis in hippocampus and hence loss of volume. This results in temporal lobe epilepsy, for which mesial temporal sclerosis is the commonest cause. This explains the convulsions as the presenting symptom in most (85%) patients.
Mesial Temporal Sclerosis was diagnosed on the basis of altered signal in the hippocampus and dilatation of temporal horns and choroidal fissure on the ipsilateral side. Dilated temporal horn was seen in all the cases and increased signal on T2 W sequences was noted in 3 cases.
According to John Stevens, Alison et al signs of hippocampal sclerosis on MRI are volume loss and increased signals on T2W sequences. They found that alteration in signal is easier to detect, but volume loss is more specific of mesial temporal sclerosis. [(45)]
In a comparison of CT and MRI, in patients with temporal lobe epilepsy by W.Schoemer, R Flex et al, it was found that out of 16 cases, 6 patients had unilateral atrophy of the temporal lobe and were only seen by MRI. They thus concluded that MRI offers advantage over CT in diagnosis of temporal lobe epilepsy due to lack of bone artifacts and coronal sections, which help to avoid partial volume effect. [(48).]

Empty Sella Syndrome

Empty Sella Syndrome was diagnosed in 5 (0.8%) patients. Age of the patients varied from 32 years to 74 years, mean age being 46 years. Females constituted 80% and male 20% of patients, giving a male to female ratio of 1:4. Headache was seen in 20% of cases, visual impairment in 40% of cases and a combination of these symptoms in 40% of cases.

Empty Sella was diagnosed based on MRI finding of an enlarged fluid filled sella, and absence of any abnormal enhancing mass in the sella. The pituitary gland is displaced postero-inferiorly and the infundibulum can be traced to the floor of the sella.

According to R. Jager and P. Rich Empty sella is a term for enlarged pituitary fossa, which is mainly filled with CSF with Infundibulum extending down posteriorly to the lower part of Sella. [35].

Benign intracranial hypertension:

Benign Intracranial Hypertension was diagnosed in 3 patients. All the patients were females in the age group of 20-35 years. The patients presented with headaches, and in one patient convulsion was the presenting symptom along with headache. MRI showed decrease size of the ventricles in all the patients and in one patient tonsillar herniation was noted as well.

Benign intracranial hypertension is a condition characterised by increased pressure at lumber puncture. The ventricles are with in normal or decreased in size with enlarged CSF spaces. Thus in appropriate clinical setting MRI is highly accurate in establishing the diagnosis and in ruling out a space occupying lesion.

A-V malformation:

A-V malformation was diagnosed in 3 (0.5%) patients. All the patients were in the age group of 21-40 years with male to female ratio of 1:2. All 3 patients had cavernous haemangiomas. The lesions were characterized by increased signal on T2 W images and low signal on T1W sequences. In 2 patients gradient echo sequences were performed and it showed decreased signals. In one patient there was a hypo intense rim around the lesion on FLASH sequences consistent with haemosiderin deposition.

In a study by Michael E, Sadek K et al of cerebral arterio venous malformations with high field MRI it was found that the nidus and the large vessels of the vascular malformation showed no signal on MRI and thus enabled better evaluation of the surrounding malformation. [49].

Follow up cases:

Out of the 565 cases, 65 were for follow-up of the previously diagnosed pathologies. 31 cases were associated with tumors. Of these, 23 cases were postoperative follow-up cases to detect tumor recurrence. The other 8 cases were for tumor follow-up to detect any interval growth. Of the 23 postoperative cases stated above MRI showed no recurrence/ residual tumor in 15 cases. Recurrence was noted in 6 cases. In 2 cases it was not possible to differentiate neovascularlisation from tumor recurrence by the pattern of enhancement at the tumor site.

Joseph T Latack et al, in their study of follow-up of 20 postoperative cases, found abnormal high signal in 6 patients at the surgical site. However no abnormality was found at surgery in these 6 cases. Thus, they found high specificity of MRI for normal reports but poor sensitivity and specificity for recurrent cases of tumor (50).

There were 8 cases for follow up for the interval growth of the tumors. Of these, 2 patients had prolactinoma, which was treated by Bromocriptine therapy, 2 patients had meningioma (one showed increase in size, the other was stable), and there was1 case each of lymphoma, metastases from lung cancer, macro adenoma and porencephalic cyst for follow up. No significant change was found in the latter group. Thus MRI was found to be a useful imaging modality to monitor tumor interval growth.

The other major groups of patients for follow-up (11 cases) were known cases of intracerebral bleed. The follow-up studies showed decrease in the size of the bleed in 9 patients and no change in the size of the lesion in 2 patients (who were deteriorating clinically).

There were 5 patients of infection for follow up, with one having a cerebral abscess. Of the 5 cases, 4 showed signs of infection decrease in size of the lesions. However in one case the lesions remained unchanged in size.

There were 2 previously diagnosed cases of infarction for follow up. The lesions did not show any change in the follow up scan.

There were 3 cases of thrombosis of cerebral venous sinuses for follow up. In 2 cases recanalization was noted. In one case, new areas of hemorrhage were noticed compared to the previous scans.

There were 4 cases of follow up, in which nonspecific signal intensities were seen in the previous scans. These signal intensities remained unchanged at the subsequent scan, and their clinical significance could not be evaluated.

There were 2 known patients of empty sella syndrome for follow up. No additional abnormality was noted in these patients.

There were follow up scans for 3-post trauma patients, which indicated contusions in previous scans. Follow up scans were done to rule out any new lesions. MRI scans showed the resolution of the previous lesions.

Congenital malformations:

3 cases were diagnosed with congenital malformations. 1 patient was diagnosed as having Chiari malformation and the other patient was diagnosed as having agenesis of corpus callosum. The patient with Chiari malformation was a 39-year-old female patient having features of congenital malformation of hindbrain in posterior fossa, which was small. There was inferior displacement of cerebellum pons and medullar along with the 4th ventricle. Syringomyelia was also noted. MRI was found to be extremely useful imaging in imaging congenital malformations due to its multiplanner capabilities

A study by Kenneth R Maravella, Thomas P et al showed that MRI defines the complex derangements associated with Chiari II malformation precisely. They found MRI due to its superior contrast resolution, artifact free images in three orthogonal planes depicts abnormally elongated, ectopic brain stem and 4th ventricle, cervico medullary kink and degree of cerebellar herniation to best advantage [51].

The patient with corpus callosum agenesis was a 6-month-old male child presenting with convulsions. However no other associated congenital malformation of the brain was noted.

In one, a repeat scan was requested to check the position of shunt in a known case of Dandy Walker malformation.

Comparison of CT and MRI:

A comparative study was done between MRI and CT for 87 patients who had a previous CT scan done. Out of the 32 patients reported as normal by CT, MRI reported normal in only 18 patients. In the remaining 14 patients MRI showed intracranial pathologies, which were missed by CT scan. This shows that MRI is able to detect more intracranial pathologies than CT.

Michael Brant-Zawazki in his paper "MR Imaging of brain tumor" states that MRI has greater sensitivity to pathological alterations of cerebral tissue and assures it would replace CT as first line diagnostic imaging for most patients with neurological manifestations [1]. According to Patrick Y .Wen et al, MRI is more sensitive than CT, enabling detection of small tumors and lesions that may be missed by CT scan [2]. The current study is also in agreement with the above stated findings.

Out of the 14 patients in whom CT was reported as normal, MRI showed the following pathologies. Infarction was diagnosed in 6 cases, infection in 1 patient, Demyelinating conditions in 4 patients and diagnosis of Mesial temporal sclerosis was made in 3 patients.

MRI made diagnosis of infarction in 19 patients as opposed to CT, which diagnosed infarction in only 9 patients. MRI was found to be superior to CT in diagnosis of infarction.

MRI diagnosed demyelinating conditions in 9 patients where as CT was not able to diagnose demyelination in any of these patients. This showed the higher sensitivity of MRI in diagnosing demyelinating conditions as compared to CT.

16 cases were diagnosed as having brain tumors by CT. MRI diagnosed tumors in one more patient than CT (that is in 17 patients). CT diagnosed bleed in that one patient, which was subsequently shown by MRI to be a complex bleed due to tumour. Vignaud, M.Bocquet et al found in a comparative study of CT and MRI for intra axial tumors that the diagnostic determination of a mass is more accurate with MRI than with CT and the extend of the mass is more precisely shown by MRI[52]. In a study Orest Boyko, Mary K Edward et al found that MRI inspite of its limitations due to long T1 and T2 signals characteristics for both Tumour and infarcts MRI is superior to CT for the differentiation of these two entities. Criteria that suggested neoplasm on MRI rather than infarct were the shape, heterogeneity of the lesion and distortion of the surrounding brain [53].

In 10 cases diagnosed to have cerebral bleed by CT, MRI found similar findings in only 4 cases. Alternative diagnosis like infection (3), infarction (2), and tumour (1) was made in the other 6 cases. This showed a higher sensitivity of MRI as compared to CT in detecting the underlying pathology of the cerebral bleed. The infarctions as shown by MRI had some areas of bleed thus justifying the CT diagnosis of bleed. In the patient diagnosed as having tumour by MRI, there were areas of hemorrhage within the tumour mass. This again justified the CT diagnosis of bleed in those patients. However, in 3 patients diagnosed as having infection by MRI, the CT diagnosis of bleed could not be justified.
MRI diagnosed mesial temporal sclerosis in 6 patients. Diagnosis of Mesial temporal sclerosis was not made on CT in these 6 patients. This showed MRI to be more reliable than CT in diagnosing this entity. However thin coronal section in region of temporal lobe with close scrutiny of the area will enable radiologist to make this diagnosis on CT.

In a comparative study of CT and MRI in patients with temporal lobe epilepsy by W.Schoemer, R Flex et al it was found that out of 16 cases, only MRI diagnosed 6 patients who had unilateral atrophy of the temporal lobe. They concluded that MRI offers advantage over CT in diagnosis of temporal lobe epilepsy. This they described was due to coronal sections, which help to avoid partial volume effect and lack of bone artifacts [48].

Thus, in this study using Cohens Kappa statistic for comparison of CT and MRI, a O.46 agreement was found. This reflects moderate agreement between the two imaging modalities (Appendix I). The percentage agreement was found to be 55.5%.

In one 13 year old male patient presenting with convulsions, bone changes were noticed in the region of sphenoid ridge on MRI scan. A diagnosis of fibrous dysplasia was then suspected and CT scan was advised for better evaluation of the bony structures.

CONCLUSION

MRI is a useful imaging modality for central nervous system examination. In a significant number of cases, MRI was found to reveal pathology not demonstrated on CT. Based on the findings of the current study, the following conclusions can be made:

MRI examination can be performed on patients of any age group. Headache is the most common symptom for patients presenting with intracranial pathologies. Headaches when associated with other neurological deficits (convulsions, limb weakness and paralysis, nerve symptoms or visual symptoms) are a more sensitive indicator of intracranial pathology.

Ischaemia is the commonest intracranial lesions detected. The mean age of presentation of ischaemic changes is 56 years and there is male preponderance. Dementia and twitching and numbness around the lips are the major presenting symptom. The lesions are found most frequently in the peri and para ventricular region and are characterized by increased signals on T2W images.

The mean age of patients diagnosed, as having infarction was 62 years with males being more frequently affected than females. Infarction is found most frequently in the areas supplied by middle cerebral artery. Acute infarction is characterized by high signals on T2W and FLAIR images. Chronic infarction is characterized by a high signal on T2W images and associated changes such as brain atrophy and encephalomalacia.

The mean age of patients diagnosed with tumor is 41 years and there is male preponderance. Headaches along with other symptoms (vomiting, cerebellar signs, nerve symptoms) are the most common presenting symptoms. Glioma is the commonest intracranial tumor followed by meningioma. Tumors are most commonly found in the frontal lobe and parietal lobe.

Gliomas are more commonly found in male patients with the mean age of presentation of 37 years. The lesions are characterized by low signal on T1W images and high signal on T2W images with a variable degree of contrast enhancement. Meningiomas have a female preponderance and are found at the mean age of 45 years. Most of the lesions are isointense to brain on both T1W and T2W images and characteristically show intense contrast enhancement. Thus post contrast scans are more reliable in detecting meningiomas than precontrast images.

The mean age of patients with infection is 27 years. Headaches along with other symptoms (fever, nausea, vomiting, photophobia, and convulsions) are the main presenting symptoms. The region most frequently involved is the parietal lobe. Infective lesions are characterized by low signal on T1W and high signal on T2W images, with post contrast enhancement.

The mean age of the patients presenting with demyelination disorders is 34 years with male preponderance. Headache and convulsions are the most common presenting symptoms. The lesions are characterized by high signal on T2W and FLAIR images.

Subacute subdural bleed presents around 53 years of age and is found more frequently in male patients. It is characterized by high signal on T1W and T2W images.

AV malformations like cavernous haemangiomas are found around 35 years of age and are found more frequently in males. Increased signal on T2W images and low signal on T1W and gradient echo sequences characterize the lesions.

The mean age of patients with diagnosed with mesial temporal sclerosis is 32 years. The lesions are found more frequently in males. Convulsions are the most common presenting symptom. The lesions are characterized by increased signal on T2W images and, reduction in size of the hippocampal region with dilatation of the temporal hom.

MRI is a highly useful imaging modality for the follow up of the patients especially the postoperative patients for tumor recurrence or residue. A negative postoperative scan is reassuring for the physician as it almost completely rules out tumor residue or recurrence.

MRI was found to be more useful than CT in detecting intracranial pathologies especially for infarction, demyelinating conditions, Mesial temporal sclerosis and infection. There was moderate degree of agreement between the two imaging modalities.

RECOMMENDATIONS

The commonest symptom of the patients referred for MRI of the brain is headache. However headache is a very common symptom and has resulted in overutilisation of MRI. This is evidenced by a large number of normal scans. Clinicians are encouraged to use internationally accepted criteria for referral of patients for MRI..

A good clinical history is mandatory for a proper evaluation of patients by MRI and to achieve a correct diagnosis. Therefore referring doctors are requested to provide adequate clinical history, examination findings and laboratory results.

This study shows MRI is a useful investigation for the diagnosis of underlying pathologies in patients presenting with convulsions. Hence MRI could be used as first line imaging modality in patients presenting with epilepsy of unknown origin.

Follow up study of patients with space occupying lesions is recommended with histopathological correlation. This will enable assessment of the specificity of MRI in diagnosis of cerebral tumors. Follow up is recommended for patients found to be normal by MRI. This would assess the sensitivity of MRI for the detection of intracranial pathologies.

Further studies to determine the role of other imaging modalities like MRI spectroscopy and diffusion weighted MRI in patients with cerebral pathologies is recommended.

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APPENDIX I

<u>Interpretation of Cohens Kappa statistic:</u>

Values	**-Degree of agreement**
0-0.2	-Slight agreement
0.21-0.4	-Fair
0.41-0.6	-Moderate
0.61-0.8	-Substantial
0.81 and more	-Almost perfect