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PROJECT REPORT

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PROGRAMME	:	**D.M. NEUROLOGY**
MONTH & YEAR OF SUBMISSION	:	**2000 NOVEMBER**

PROJECT REPORT

TITLE :

UTILITY OF MAGNETIC RESONANCE IMAGING IN NEUROLOGICAL AND NEUROSURGICAL DISEASES

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PROGRAMME : **D.M. NEUROLOGY**

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Name	
Page	of
Date	

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JOY M.A.

CERTIFICATE

I, Dr. JOY M. A hereby declare that I have actually performed all the procedures listed/ carried out the project under report.

Signature.....

Place :

Date :

Name in capital letters

JOY M. A

Forwarded. He has carried out the project under report.

Signature
Head of the Department

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM	Name	
	Page	of
	Date	

CONTENTS

		Page No
1.	INTRODUCTION	1
2.	AIMS OF THE STUDY	3
3.	MATERIALS AND METHODS	4
4.	REVIEW OF LITERATURE	5
5.	RESULTS	14
6.	DISCUSSION	20
7.	REFERENCES	24

INTRODUCTION

Exciting developments in the field of radiology are paving way for more and more useful diagnostic facilities. X-ray has already become a thing of the past and is almost thrown out of the neurodiagnostic armamentarium. Even CT scan a somewhat recent imaging technique has been replaced by magnetic resonance imaging (MRI) and has become the examination of choice for most neurological conditions.

The radiologists are prone to procedures that they enjoy and that far too many radiological publications are uncritical in their praise for recently developed procedures.

There should be an intention to attempt to indicate which imaging tests are likely to provide the information most appropriate for the management of the patient. Regrettably in the countries from which the bulk of the literature arises, there are strong motives for both promoting the use of medical facilities and for publishing ones work, which may explain the remarkable, and sometimes lamentable absence of outcome studies. There is very little evidence that outcome of patients even with the surgical disease has been appreciably improved by the most recent advances in imaging. Indeed, such studies as have been performed have produced very disheartening results showing no long lasting improvement in the quality of our patients' lives.

Outcome in this sense is of course, not the only measure. The great advantage of many modern imaging techniques is that the patients endure far less unpleasant experiences or run less risk to achieve the outcome.

We are still going through a phase, familiar to radiologists, in which patients are submitted to multiple tests which essentially yield the same information. Thus a many patients currently undergo both CT and MRI when either, or even neither, would suffice.

Whenever an investigation is asked for, certain basic questions should be answered,

1) Do I need it?

2) Has it been done already?

3) Do the radiographer and the radiologist understand what I need to know and why?

4) Is this the best study?

And lastly the most important of all

5) Is this test really likely to have an impact on my management of this patient? If not, will it nevertheless give data which will genuinely help my understanding of this disease and management of other patients with similar problems?

The present study is intended to be done to answer some of these questions as far as MRI is concerned in neurology. This being a very costly investigation to many of our patients, its usage has to be pruned to areas where the technique is definitely going to be helpful in patient management.

AIMS OF THE STUDY

1) To study whether MRI was done with a clear set of differential diagnosis in mind before the investigation was ordered.

2) To study the correlation between the clinical and MRI diagnosis.

3) To know whether MRI really helped in patient's ultimate management.

4) Whether prognosis was altered with the imaging.

MATERIALS AND METHODS

Hundred cases of cranial and spinal MRI done for evaluation of neurological as well as neurosurgical diseases were analyzed prospectively. The clinical indication for imaging, differential diagnosis entertained were compared with clinical diagnosis and other diagnostic procedures like computerized tomographic scanning.

It was studied whether MR imaging really mattered in patient's management and whether outcome was altered.

REVIEW OF LITERATURE

Magnetic resonance imaging has revolutionized neuroimaging. Many internists are now familiar with the technology. However, strong support for a greatly expanded role of MRI in the diagnosis and management of neurological diseases is lacking because the evidence for clinical efficacy in the published literature is incomplete. (1)

On the basis of a multicenter evaluation and appraisal of relevant literature, a conscious statement of the Australian Health Technology Advisory Committee endorsed a view that MRI is superior to CT and other tests in the detection and delineation of most disease processes of the central nervous system (brain and spinal cord). (2)

SAFETY, TECHNICAL ISSUES AND COSTS.

Safety evaluations indicate that MRI is safe for most patients including pregnant women. (3) Paramagnetic contrast agents improve confidence in diagnosis in 45% to 75% of scans and actually change the apparent diagnosis in upto 30% of patients (4). Paramagnetic contrast agents cross the placenta and typically are contraindicated during pregnancy, but all are otherwise safe. Minor adverse reactions to the agent occur in 2% to 3% of patients and anaphylaxis occurs in about 1 in 100,000 patients (5).

Costs of MRI historically have been high compared with competing technologies. Facility and professional charges for MRI are 30- 100% higher than for CT (6).

USE OF MRI IN STROKES AND TIA

The clinical diagnosis of the cause of a stroke is erroneous in 10 to 20% of patients (7). Because spatial resolution of MRI has improved smaller infarctions have been seen often on the first day after onset of the illness. Among several studies the sensitivity of MRI for infarction ranged from 0.86 to 0.95, where that of CT ranged from 0.50 to 0.68. The impact of MRI on final diagnosis or therapeutic choices for patients with stroke has been reported. In one study MRI reportedly led to a change in diagnosis of cause of stroke for 16% of patients and to change the anticoagulation management for 19% (8). No studies have investigated changes in patient outcomes attributable to the use of MRI after stroke.

CAROTID ARERY DISEASE AND MAGNETIC RESONANCE ANGIOGRAPHY.

In recent studies the sensitivity of MRA for angiographically significant stenosis ranged from 0.86 to 1.0. Stenosis by MRA correlated exactly with conventional angiography in 50 to 90% of arteries reported (9).

Although a combination of duplex and MRA has been suggested as a replacement for conventional angiography, no methodologically satisfactory studies have yet reported data showing that MRA changes therapeutic choices or improves patient outcomes.

INTRACRANIAL HAEMORRHAGE AND ANEURYSMS

MRA and MRI may improve detection of small intracranial aneurysms, but spatial resolution is not adequate for planning aneurysm surgery (10). Leading centers in the world have reported initial successes in doing stereotactic radio surgery guided by MRI for vascular malformations,

but the therapeutic impact and patient outcome for hemorrhage and aneurysm have not been studied rigorously.

DEMENTIA.

Interpretation of incidental abnormalities of white matter and clinically silent infarction seen on MRI in older people is problematic. The prevalence of abnormalities increases from 20% in patients younger than 50 years to 90% for those older than 70 years. The prevalence doubles or triples with each age group when diabetes, hypertension or cardiac disease is present (11). White matter abnormalities generally correlate with cognitive decline on formal testing, but long term follow up of healthy elderly patients has shown that many people with white matter abnormalities have no loss of cognition (12). Correlation between abnormalities in hippocampus and Alzheimer's disease are reported, but studies also suggest that Hippocampal atrophy is common among healthy elderly persons (13).

No studies of the accuracy of MRI alone compared with CT for detection of treatable lesions in demented patients have been published. In a study, fewer than 5 % of patients with dementia had reversible causes (14). In a prospective study of 210 demented patients, 12 % had potentially treatable lesions discovered by MRI or CT . Only 4 had treatment and none improved as a result (15).

BRAIN NEOPLASMS

Patients with metastatic or primary brain tumours may show progressive neurological symptoms, have seizures or be symptomatic. Once a tumour is diagnosed, most centers use MRI to define its margins and effects on adjacent structures. However infiltrating primary brain tumours often

extend beyond MRI and CT abnormalities (16). MRI always shows more anatomic details than CT. MRI shows Cerebello pontine angle and lower cranial nerve tumours better than CT, although false positive images do occur. Enhancement of meningeal metastasis with paramagnetic contrast is not reliable enough for definitive diagnosis (17).

Few studies have evaluated diagnostic accuracy in a case series of patients suspected of having brain tumours. In a recent study MRI detected more presumed metastatic lesions than CT, but independent confirmation of the lesion was not obtained (18).

MRI is more sensitive than high resolution CT for detection of sellar and juxta sellar lesions. Lesion margins are better defined by MRI. With either test, false positive results may occur because of clinically silent pituitary abnormalities.

Only a few studies examined the impact of MRI in the treatment of neoplasms. In a comparative study of treatment planning according to CT or MRI, neither test was superior (19). In planning treatment volumes for radiation therapy, the measurement variation between CT and MRI derived volumes was no greater than inter observer variation in such measurements (20).

EPILEPSY

In patients with epilepsy, abnormal results on MRI in retrospective case series have varied from 21-71% (21). MRI improves diagnosis when the history, physical examination or the EEG suggests a focal lesion (22). In one study reporting apparent false positive findings on MRI, the investigation attributed the errors to incomplete patient sampling at surgery rather to

misinterpretation of the MRI scans (23). Some asymmetry in temporal lobe structures is normal and may be a source of misleading images (24). Studies indicate that abnormalities or atrophy of the hippocampus seen on MRI correlates with abnormal pathological findings and predict the location of seizure focus (23).

INFECTIOUS DISEASES

MRI is study of choice for imaging infections and inflammation of brain and spine (24). Most recent studies investigated spinal and brain infections related to AIDS. Recent expert opinion indicates that paramagnetic contrast agents should be reserved for unusual lesions because few diagnosis and fewer treatment plans would altered by the routine use of these agents. No study has reported improved patient outcomes.

MULTIPLE SCLEROSIS AND RELATED SYNDROMES

MRI shows white matter findings typical of MS in 70 to 95% of clinically definite cases and reported specificity ranges from 0.7 to 1.0 (25). When rigorously evaluated, interpretation of MRI that gave sensitivities of 0.6 or 0.8 for MS were associated with specificities of 0.75 and 0.91 respectively, depending on the definition of imaging abnormalities (26). The problem of false positive findings increases with age. Use of MRI may have little overall diagnostic effect. In a census area of 250,000 people, only 3% of 72 new diagnoses of MS would have been delayed without MRI (27).

MRI has had little direct impact on therapeutic or patient outcome in MS. Recent reviews have focused on the information value of MRI for the clinician scientist rather than for the clinician practitioner (28). If MRI allows more rapid evaluation of new therapies, its value in patient care through research may be considerable.

SPINAL DISEASES

MRI has become the preferred modality for imaging spinal diseases ranging from radiculopathy to spinal cord injury (29). For spinal column metastasis and spinal cord compression, MRI requires no intrathecal injection, images the entire spine rather than just the spinal cord and gives more precise imaging of metastasis. For detecting and managing syrinx, MRI is the moat comprehensive imaging modality (30).

In spinal trauma and cervical myelopathy, studies show high concordance between neurological status and abnormal MRI findings in the spinal cord (31). The incremental gain from using MRI for prognosis is unknown and clinicopathological correlations are not available. Most authors suggest that CT is required for patients with suspected bony injury (32).

With the intervertebral disc, loss of MR signal intensity indicates physiological degeneration of the disc. The relation between loss of disc signal and back pain is not clear. In patients with lumbar herniated discs, shrinkage of the herniated fragments seen on MRI correlates with symptomatic recovery in patients who do not undergo surgery (33).

In the postoperative spine, MRI differentiates between scar tissue from recurrent disc herniation better than does postmyelogram CT scan. Paramagnetic contrast agents enhance scar tissue and may improve definition of scar from disc (34).

For causes of spinal radiculopathy a recent meta analysis indicated that MRI and myelographic CT had equivalent sensitivity and specificities although myelography was less accurate.

Studies of MRI in asymptomatic persons suggest that between 10-

30% have herniated or bulging discs (35). Similarly from 5- 30% of asymptomatic patients had spinal stenosis by imaging, which could be considered false positive results depend on how abnormalities are defined (36).

In recent case series of spinal imaging, using MRI as the first test obviated the need for more than half of the CT scans and more than 90% of the myelograms (37).

MISCELLANEOUS DIAGNOSIS

In the brain stem and posterior fossa, MRI shows more lesions of all types than does CT. In a well-designed and informative study, Scottish investigators randomized the choice of first test for a large series of patients with suspected posterior fossa lesions, and then allowed clinicians to proceed as they wished with the remainder of patient care decisions (38). When MRI was the first choice, 6% of patients also had CT, whereas 19% of patients had MRI when CT was the first test. MRI changed 23% of diagnosis made by CT, whereas CT changed 18% of MRI diagnosis. However this result was not statistically significant. The major reason given for getting the other test after CT or MRI alone was a desire to further clarify the diagnosis. One other study reported that MRI changed the final diagnosis in 16% of patients.

THERAPEUTIC IMPACT ON PATIENT OUTCOMES

Several studies have reported changes in treatment plan after MRI. In the Scottish study, MRI after CT changed 6% of treatment plans for patients

with posterior fossa disease and CT after MRI changed 2% of plans. In an observation study, MRI resolved uncertainty about treatment choices in 70% of 113 patients and redirected the treatment choice in 39% of 69 patients (38).

Quality of life survey scores from the patients were unchanged from before the MRI upto 4 months after MRI. In a large prospective study from England, MRI findings alter treatment for 27% of patients (39). However, functional disability scores worsened, a finding attributed to the underlying serious illness present.

OTHER DISEASES AND SYNDROMES

Cranial nerves can be imaged with high resolution MRI. With MRI and MRA, vascular compression of the trigeminal nerve and the facial nerve has been associated with trigeminal neuralgia and hemi facial spasm respectively (40).

In common clinical syndromes where the prevalence of structural disease is already low, the diagnostic yield of MRI also is low. In several studies of headache no clinically significant mass lesions were found. Among patients with dizziness abnormal MRI findings were prevalent in controls as in the dizzy patients and no treatable causes could be identified (41).

MRI may define structural correlates of parkinsonian syndromes and other degenerative diseases of brainstem or cerebellar nuclei. However clinical

usefulness have not been shown.

Two conclusions emerge from the review of clinical efficacy of MRI for neuroimaging. First, MRI yields high quality images. Second, although MRI holds great promise for improving clinical management, qualitative rigorous assessments of the clinical effects of MRI in large case series or well-controlled comparison trials are missing.

RESULTS

Age	group:
< 10 yrs	8
< 20 yrs	14
< 30 yrs	20
< 40 yrs	19
<50 yrs	18
<60 yrs	14
<70 yrs	5
<80 yrs	2

Sex

Male	49
Female	51

Diagnosis

Generalised epilepsy	3
Focal seizures	8
West's, LGS	3
Ischemic stroke	9
Hemorrhagic stroke	2
Meningitis	3
Degenerative disease	1
Spondylotic disc disease	10
Compressive myelopathy	5
Infections,TORCH	2
Encephalitis	3
Demyelinative brain disease	2
Demyelinative spine disease	1
TGA	1
Neurometabolic disease	1
BPPV	1
ICSOL	41
Migraine	1
CSF Rhinorrhoea	1
Syringomyelia	2

PARTS SCREENED:

Brain	78
Pituitary fossa	3
Cervical spine	13
Dorsal spine	3
Lumbar spine	1
Multiple regions	2

Referred by:

Neurologist	61
Neurosurgeon	39

Clinical Examination

Normal	36
Abnormal	64

CT Scan

Done	41
Not done	59

CT Corroboration with clinical diagnosis

Yes	31
No	10
Not done	59

MRI Normal/Abnormal

Normal	20
Abnormal	80

Clinical correlation with MRI

Yes	81
No	19

Management

Medical	75
Surgical	25

Cost

Rs.2500	9
Rs.5000	51
> Rs.5000	40

Income

A	9
B1, B	25
C	19
D	54

MRI was required for diagnosis

Yes	86
No	14

MRI needed for management

Yes	75
No	25

Patient had real benefit with MRI

Yes	44
No	56

MRI changed CT diagnosis

Yes	19
No	22

Benefit with MRI

Cases referred by Neurologist

Yes	17
No	44

Cases referred by Neurosurgeon

Yes	27
No	12

DISCUSSION

One hundred patients were studied with both neurological and neurosurgical diseases to assess the clinical effectiveness of MRI.

Indications, for which MRI was ordered though varied, were done for bettering diagnosis and management and especially to look for surgically ameliorable lesions. Fifty-nine patients underwent neuroimaging to look for surgically correctable pathology and both neurologists and neurosurgeons referred these patients.

Though in many of the patients CT scan was already done, an MRI was ordered for better anatomical delineation of the lesion. This is the usual strategy used by neurologists and neurosurgeons worldwide.

In 41 patients CT was done prior to MRI and in 19 MRI made a change in the diagnosis. This is high when compared to the Scottish study where MRI changed the diagnosis in only 23% of cases.

There was good clinical correlation with MR imaging results, 80% of MRI findings having correlated with the clinical diagnosis. A few studies were done for no real neuroimaging indications. This may be the reason why 20% of the MRI results came as normal.

Few of the instances where neuroimaging was not really warranted included 3 cases of primary generalized epilepsy, and one case each of transient global amnesia and benign paroxysmal positional vertigo. There were no real reasons indicated in the MRI request forms for ordering the test in these patients.

One patient with classical history of migraine also underwent MRI whish also turned out to be negative. In several studies of headache no clinically significant lesions were found (42) and now several authorities feel that routine neuroimaging is not indicated in cases of classical migraine.

Among these 100 patients it was found that MRI was required for the diagnosis in 86 patients though in many patients just CT would have helped. But in 59 patients the referring doctors preferred to image the patient with MRI first. Many a time this is done because of the better delineation of the lesion with MRI. The cost difference between CT and MRI is around Rs 2000-4000. If Ct is done first and the lesion is not clearly made out then MR would have to be done. To save the cost of the CT physicians prefer magnetic resonance imaging first.

MRI was needed for patient management in 75 patients out of the 86 in whom it was required for diagnosis. As expected this was more in the neurosurgical cases where lesion delineation was more indicated.

In neurological cases, MRI picked up lesions like small lacunar infarcts which were missed by CT scan. But in many patients though more abnormalities could be detected, this did not change the management strategies significantly.

Real benefit for patients from the MRI was seen only in 44%. In the rest the imaging did not benefit the patients substantially. In many of the patients lesser costlier investigations like CT would have been enough for the management.

Out of the 61 cases referred by the neurologist outcome was altered in only 17 patients. This is because most of the neurological conditions were

ones where a surgical treatment couldn't be offered and modern neurotherapeutics is not developed enough to change the patient outcomes.

Among the 39 cases referred by neurosurgeons, 27 patients had good outcome with neuroimaging. Among the 12 patients who did not have benefit as far as outcome is concerned many of the conditions were inoperable and some of the conditions required only follow-up.

Among the conditions which benefited patients and referred by the neurologists included complex partial seizures of the temporal type which could be managed surgically bringing down the seizure recurrence. Other conditions included space-occupying lesions like tuberculoma which could be appreciated well by MRI and managed medically. Demyelinating lesions in the spinal cord can be diagnosed by no other modality as such patients too were very much helped by MRI.

Patients with cervical myeloradiculopathy presenting with pain, spasticity etc who are often referred to neurologists for clarification of diagnosis are also help by MRI as compressive etiology can be definitely ruled in or out with the help of MRI.

In conditions like cerebro-vascular accidents, degenerative diseases like Rett's syndrome, atypical Parkinson's disease etc may not achieve results with MRI which could be used to help patients. But imaging procedure for these conditions may be required in research settings were more and more knowledge is required for the better understanding of the disease and making use of the knowledge in further advances in treatment.

The results of the present study are similar to studies done elsewhere (39) which show that though people resort to the newer advances in imaging

for diagnosis and management, these tests make a significant change and enhance the quality of life only in a limited number of cases. A large prospective English study found that MRI findings altered treatment plans and improved quality of life only in 27% of the patients. (42)

The data indicate a substantial impact of MRI on the diagnosis of diseases of the brain and spine when the clinician refers the patient for such an investigation. Despite the recent introduction of the modality, clinical physicians using MRI obviously have come to rely considerably on results of the examination in terms of altering the diagnosis, establishing the confidence in the diagnosis, and even affecting treatment and prognosis.

It may seem disappointing that investigation like is not accompanied by any improvement in quality of life, but there are several reasons why this did not occur. Most of these patients had chronic conditions which might not change over the study period. Even for a condition that might be influenced by surgery, improvement may be delayed until after the immediate post operative effects have subsided. Further more residual disability is to be expected after some successful operations. In conditions such as multiple sclerosis that have an intermittent course, the quality of life will be affected by the disease process rather than by any benefits of the test.

As far as imaging tests are concerned, the referring physician is the ultimate "consumer", perhaps more so than the patient. Thus whether a new imaging test assist the clinician's understanding and the management of the patient is the paramount arbiter as to whether the new test is helpful or not. Although the clinical conditions may not be improved through the use of MRI, patients can be assured that they have had an efficacious test and that their clinician is, in general, more confident about the diagnosis upon which to base subsequent management.

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