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ORIGINAL ARTICLE

Diagnostic Accuracy of Magnetic Resonance Spectroscopy in Differentiating Malignant and Benign Brain Lesions

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ABSTRACT

The aim of this study is to determine the diagnostic ability of magnetic resonance spectroscopy in separating malignant and benign cerebral masses, when histopathology taken as gold standard. The results of my study will not only resolve this controversy but also If MRS diagnostic accuracy will be found high in distinguishing ring enhancing lesions of brain, then this non-invasive modality can be applied routinely in our general practice for proper treatment selection the lesions in order to reduce the morbidity and mortality of these particular patients.

Materials & Methods: We included around 141 cases presenting to us at the Radiology department of Sir Ganga Ram Hospital, Lahore, fulfilling the inclusion criteria was selected after we got approval for the study from IRB committee of university. Informed consent was taken from each patient. We performed magnetic resonance spectroscop in each case using 1.5 Tesla MR system having graded power of 33 mT/m and results of MRS were read and reported by one radiology consultant. Malignant or benign lesions were noted on MRS. After this, each patient was undergone biopsy in the concerned ward by the consultant neurosurgeon and tissue was sent to institutional pathology laboratory for histopathology. Histopathology results were interpreted by the consultant histopathologist (at least 3 years of post-fellowship experience) and benign or malignant lesion was noted

Results: All the included cases underwent standard magnetic resonance spectroscopy (MRS) of brain. MRS strengthened the suspicion of malignant brain lesions in 94 (66.67%) cases. Histopathology findings confirmed malignant brain lesions in 90 (63.83%) cases.

Conclusion: This study concluded that MRS is the non-obstrusive method of imaging with greater diagnostic accuracy in differentiating malignant and benign brain lesions, and that it has not only made drastically better our capability to identify malignant brain lesions preoperatively, and moreover assists neurosurgeons in taking much better decisions. As a result, we urge that MRS be performed habitually in all suspected instances of intracranial mass lesion for reliable pre-operative identification of malignant brain lesions and selection of appropriate surgical technique.

Keywords: MRS. MRI. Brain lesions, brain tumor, CNS tumor, Magnetic resonance spectroscopy

INTRODUCTION

A cerebral lesion is an aberration discovered during a neuroimaging test like as magnetic resonance imaging (MRI) or computed tomography (CT). Cerebral lesions develop on CT or MRI images as dark or bright patches that do not seem to be healthy brain structure. A cerebral tumor is typically an unintentional discovery irrelevant to the ailment or complaint that prompted the neuroimaging test to start with.[1] A brain lesion can affect smaller as well as larger parts of the CNS, and the intensity of the underlying illness can span from pretty trivial disease to a lethal one [2] When a patient is admitted in for an appraisal of a specific brain abnormality, it can often be hard to discern in both tumoral and non-tumoral neurological complications, which regularly generates a quandary for physicians and surgeons for some further planning.[3, 4] According to one research, the frequency of aggressive brain lesions is 63.0%. [5] The early the diagnosis, the better the prognosis [6].

In past few years, advances in Magnetic Resonance Imaging (MRI) have enabled accurate diagnosis of a wide range of disorders, especially brain tumours (BT), with either an efficiency ranging from 30 to 90% based on the kind of tumour. Though MRI has improved diagnostic specificity, conventional MRI configurations may still be unable to distinguish between distinct cerebral pathologies. An evidence of malignancy often appears as a firm enhancing mass with a very well localized boundaries and significant edoema. Core necrosis can sometimes result in a ring-enhancing lump. This type of condition is hard to discern from an abscess. Furthermore, diffusion and spectroscopic patterns have demonstrated effectiveness in distinguishing them [7].

Magnetic resonance spectroscopy (MRS) is a fast emerging discipline of neuroscience that enables for passive and in vivo molecule measurement. It stimulates a tiny region of material (voxel) preferentially employing concentrations, captures the free induction decay (FID), and generates a rainbow from the FID emanating from that voxel. MRS has better screening capacities by allowing material classification regarding the molecular makeup. It contains data on cell growth, degeneration, neural viability, and glucose metabolism. MRS seeks to distinguish among both benign as well as malignant brain lesions depending on these properties.[8,9] One study has shown the sensitivity and specificity of magnetic resonance imaging in differentiating malignant and benign brain lesions as 91.0% and 90.5% respectively.[10] Another study has shown the sensitivity and specificity of magnetic resonance imaging in differentiating malignant and benign brain lesions as 80.05% and 78.46% respectively.[11]

Since there is a controversy in previous literature regarding diagnostic accuracy of magnetic resonance imaging in differentiating malignant and benign brain lesions, so there must be need of more research on this topic. Also I have found no local study on this topic in the last five years, so there must be re-evaluation of the data. The rationale of this study is to calculate the diagnostic ability of MRS in separating malignant and benign cerebral masses, when histopathology taken as gold standard. The results of my study will not only resolve this controversy but also If MRS diagnostic accuracy will be found high in distinguishing ring enhancing lesions of brain, then this non-invasive modality can be applied routinely in our general practice for proper treatment selection the lesions.

MATERIALS & METHODS

We included around 141 cases presenting to us at the Radiology department of Sir Ganga Ram Hospital, Lahore, fulfilling the

inclusion criteria was selected after we got approval for the study from IRB committee of university. Informed consent was taken from each patient. We performed magnetic resonance spectroscopy in each case using 1.5 Tesla MR System having graded power of 33 mT/m and results of MRS were read and reported by one radiology consultant. Duratio of the study was 12 months from September 21 to October, 2022. Malignant or benign lesions were noted on MRS. After this, each patient was undergone biopsy in the concerned ward by the consultant neurosurgeon and tissue was sent to institutional pathology laboratory for histopathology. Histopathology results were interpreted by the consultant histopathologist (at least 3 years of post-fellowship experience) and benign or malignant lesion was noted. Magnetic resonance spectroscopy findings were compared with histopathology report. This all data (age, gender, size of lesion, duration of disease) was recorded on a specially designed proforma. Age, duration of disease and size of lesion analyzed and reported in term of mean values. Gender and type of lesion (benign/malignant) on MRS and histopathology were presented as frequency and percentage.

RESULTS

This study included participants ranging in age from 20 to 60 years old, with the mean age being 40.96 9.27 years. The majority of the patients (71 out of 100, or 50.35%) were between the ages of 20 and 40. With a ratio of 1.8:1, there were 91 male patients (64.54%) and 50 female patients (35.46%) out of these 141 total patients. All the included cases underwent standard magnetic resonance spectroscopy (MRS) of brain. MRS strengthened the suspicion of malignant brain lesions in 94 (66.67%) cases. Histopathology findings confirmed malignant brain lesions in 90 (63.83%) cases. In MRS positive patients, 85 were True Positive and 09 were False Positive. Among 47, MRS negative patients, 05 were False Negative whereas 42 were True Negative (p=0.0001) as shown in Table I.

Table-1: Diagnostic accuracy of MRS in differentiating malignant lesion with benign brain lesions (n=141)

	Malignant brain lesion on Histopathology	Benign brain lesion on Histopathology	P-value
Malignant brain lesion on MRS	85 (TP)*	09 (FP)***	0.0001
Benign brain lesion on MRS	05 (FN)**	42 (TN)****	

*-TP=True positive **-FN=False negative ***-FP=False positive ****-TN=True negative

Sensitivity: 94.44%
Specificity: 82.35%
PPV: 90.43%
NPV: 89.36%
Diagnostic Accuracy: 90.07%

Overall sensitivity, specificity, PPV, NPV and diagnostic accuracy of magnetic resonance spectroscopy in differentiating malignant and benign brain lesions, taking histopathology as gold standard were 94.44%, 82.35%, 90.43%, 89.36% and 90.07% respectively. Stratification of diagnostic accuracy with respect to age groups and gender was done which was statistically significant, showing that age (p= 0.001) and gender (p= 0.001) of the patient are significant factors in determining the diagnostic value of MRS for brain lesions.

DISCUSSION

Regionalized proton MR spectroscopy (MRS) of the neural network, which was initially described well over a decade ago [12, 13], is a reasonable methodology that is utilised practically in many healthcare facilities around the globe to evaluate brain malignancies. While investigations of brain imaging tumours have been conducted utilising heteronuclei such as phosphorus (31P) and sodium (11Na), the proton (1H) nucleus is used in the vast majority of spectroscopic research due to its great sensibility and simplicity on contemporary Mri machines. As a result, this analysis will concentrate on proton MRS in neurological cancers [14, 15].

During the infancy of the human brain proton MRS, it was discovered that brain tumours had significantly distinct spectra than healthy neural tissue.[12] It was observed that approximately all brain tumours have lessened N-acetyl aspartate (NAA) signals and frequently have significant amounts of Choline (Cho), leading to greater Cho/NAA ratios. Because NAA is thought to be predominantly of neuronal and axonal source, the reduction in NAA is usually understood as the death, malfunction, or relocation of normal neural tissue. The 'Cho' signal is made up of numerous distinct choline-containing chemicals that are engaged in membrane production and breakdown; it has been proposed that it is enhanced in brain tumours due to increased transmembrane recycling. According to in vitro investigations, the enhanced Cho signal in brain tumours is caused by higher amounts of phosphocholine (PCho). Cho has also been observed to made a significant impact with tumour cellular density[12] and tumour penetration into cerebral cortex .[13]

This research was carried out to investigate the diagnostic performance of magnetic resonance spectroscopy in distinguishing between malignant and benign neurological problems, using histopathological examination as the gold standard. MRS confirmed the presence of malignant brain lesions in 94 (66.67%) of the cases. In 90 (63.83%) of the patients, histopathology findings revealed malignant brain abnormalities. In MRS positive patients, 85 were True Positive and 09 were False Positive. Among 47, MRS negative patients, 05 were False Negative whereas 42 were True Negative (p=0.0001).

One study has shown the sensitivity and specificity of magnetic resonance imaging in differentiating malignant and benign brain lesions as 91.0% and 90.5% respectively.[12] Poptani et al., [15] showed 89% diagnostic performance with proton MR spectroscopy in a major clinical investigation involving 98 individuals having cerebral tumors. In another prospective research of 120 respondents with cranial abnormalities, proton MR spectroscopy was found to have a classification yield of 85.6%.[16] Moller-Hartmann et al[17] revealed that the presence of proton MR spectroscopy enhanced the diagnostic performance of traditional MR tomography by 15.4% in their cohort. Muhammad et al showed the positive predictive value of MRS in the diagnosis of malignant brain lesion was 94.9%.[13]

Alshammari et al discussed the diagnostic accuracy of MRS for differentiating neoplastic from non-neoplastic lesions. The diagnostic accuracy of MRS was 100%, with about 83% sensitivity, about 86% specificity, 95% PPV, and 60% NPV. [14]

Sarah et al showed sensitivity of MRS as 72%, specificity of 84%, PPV of 91%, NPV of about 58% and diagnostic accuracy of 76% in differentiating benign from malignant lesions [15].

As discussed and reported, MRS is the non-invasive imaging technique that has the highest diagnostic accuracy in differentiating between benign and malignant brain lesions. Not only has this significantly boosted our capacity to identify potentially cancerous brain lesions prior to surgical removal, but it also helps neurosurgeons arrive at decisions that are more well-informed. Therefore, we strongly suggest routinely employing magnetic resonance spectroscopy (MRS) in all cases where an intracranial mass lesion is suspected. This will allow for accurate pre-operative diagnosis of malignant brain lesions and the selection of the surgical approach that is most appropriate to treat them.

CONCLUSION

Based on the findings of this research, magnetic resonance spectroscopy is the non-invasive imaging method with the highest diagnostic accuracy in distinguishing malignant from benign brain lesions. This has not only greatly improved our ability to identify

malignant brain lesions pre-operatively, but it also aids neurosurgeons in making more informed decisions. Therefore, we strongly suggest routinely employing magnetic resonance spectroscopy (MRS) in all cases where an intracranial mass lesion is suspected, as this will allow for accurate pre-operative diagnosis of malignant brain lesions and the selection of the most appropriate surgical approach.

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