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ORIGINAL ARTICLE

Comparison of Diagnostic Accuracy of Magnetic Resonance Spectroscopy with Conventional Magnetic Resonance Imaging for Brain Tumors and Correlation with Histopathology as Gold Standard

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ABSTRACT

Background: In spite of recent advances in the use of diagnostic imaging modalities none of them has a hundred percent accuracy. So, misdiagnosis still occurs. Many trials are being done to evaluate the accuracy of these tools individually or in combination. The most useful investigation is MRI which broadly gives information of lesion as well its relationship with surrounding structures. While magnetic resonance spectroscopy further characterizes the lesion into benign or malignant. So this study is bit superior giving more details. By enlarge histopathology is gold standard for ultimate diagnosis. However these radiological investigations are extremely important for preoperative planning as well management of the lesion. In this study we compare the diagnostic accuracy of Magnetic Resonance Spectroscopy (MRS) with conventional MRI (Magnetic Resonance Imaging) sequences for diagnosis of brain tumors keeping histopathology as gold standard.

Methods: The study was performed in 150 clinically suspected cases which were referred to Radiology Department from OPD, Indoor, Emergency and private sources from outside the hospital.

Results: Majority 85(56.7%) were adult males and 65(43.3%) were adult females. The study was divided into two major age groups. There were 33cases (22%) with average age 20-35 years. The other age group 36-50 years had 40(26.7%) Majority of the cases 77(51.3%) were of average >50 years of age. The higher age groups showed a female dominance. Histopathology of 100(66.7%) cases confirmed positive and 50(33.3%) negative for MR Spectroscopy. On comparison of conventional MRI with contrast, and Histopathology it was observed that the sensitivity of MRI was 74.0% and the specificity 82.0%.The positive and negative predictive values gave a lower accuracy rate of 76.6%.

Conclusion: The conclusion of our study is that MRS is a rigorous, non-invasive, safe and convenient imaging modality for the evaluation of brain tumors as compared to MRI.

Keywords: Brain tumors, MRI, MRS, Histopathology

INTRODUCTION

The incidence of all primary malignant and non-malignant brain and CNS tumors is 18.71 cases per 100,000 (7.3/100,000 for malignant tumors and 11.52/ 100,000 for non- malignant tumors) in 2011 [1]. Primary brain tumors are found in more than fifty percent of cases of intracranial lesions. Brain tumors may originate primarily from within the neural tissue or they may represent metastases from a remote focus. The diagnosis and differentiation of benign from malignant brain lesions becomes difficult at times. Routine CT and MRI, the first line imaging modalities, however do not always provide precise information regarding cellularity, vascularity and of the lesion[2]. MRI with intravenous contrast is an excellent modality for visualization and characterization of many tumors, there is however a significant number of times when diagnostic dilemma persists because of similarities and atypical features of brain lesions. Therefore, patients have to go through invasive surgical procedures for biopsy to rule out malignancy. Magnetic resonance spectroscopy (MRS) also known as nuclear magnetic resonance spectroscopy (NMR) is a current advance technique that gives information about metabolism of living brain metabolites. Magnetic resonance spectroscopy is a non-invasive analytical method to differentiate benign and malignant tumors as well as to characterizing the malignant neoplasms. It can be done as a part of routine MR imaging on commercially available MRI instrument[3]. By comparing the relative peaks and ratios of various metabolites concentration, the neuronal function and membrane turn over within volume of interest can lead to diagnosis of underlying pathology[3]. MRS will aid not only in classifying the pathology within brain but will also be able to calculate the effects of anti-tumor therapy by measuring abnormal metabolite ratios in selected voxels.

MATERIALS AND METHODS

This study was conducted in the department of Radiology Shaikh Zayed Postgraduate Medical Institute and Hospital Lahore, which is a tertiary care hospital. The study was conducted from January 01, 2018 to December 31, 2019. This is comparative cross sectional and single cross sectional study Total 150 patients were included in this study who gave consent to be included. Inclusion criteria was designed for the following patients; patients with age ranging from 20 to 65 years referred from, indoor, outdoor, and emergency departments besides those referred from private sources outside the hospital with clinical signs and symptoms suggesting of brain tumor, showing non-specific or/and inconclusive CT and MRI reports. Patients having strong contra-indications to MRI e.g. those with cardiac pace makers, metallic stents, brain aneurismal clips and

cochlear implants, patients with recurrent tumors, unstable patients with uncontrolled body movements and jerks, and those with life expectancy less than three months were excluded from the study. The patients who fulfill the inclusion criteria were included in the study. The history and clinical data were recorded on proforma .Informed consent was signed by all the patients .All scans were performed on GE 1.5 Tesla MR scanner using head coil. Axial T1W, T2W, FLAIR, Sagittal T1W, T2W, Coronal T1W besides multiplanar, post-contrast T1W sequences were obtained.MR spectroscopy was performed by single voxel technique. After water suppression, a point-resolved spectroscopy (PRESS) technique was used for localization and the studies were obtained with TE and TR of 135 and 1500 respectively. Consultant radiologists, well experienced in MR Spectroscopy, interpreted all images. Final diagnosis was made on histopathology results. The reports of biopsy were collected and co-related with radiological diagnosis of MRI and MRS. The collected information was entered in SPSS v23.0. Data for age was recorded using Mean standard deviation. Data for gender and positivity in MRI and MRS and on histopathology were recorded using frequency and percentage with 95% confidence interval. Sensitivity Specificity, PPV, NPV and accuracy of MRI and MRS against histopathology findings were reported by using percentage with 95% confidence interval.

RESULTS

The study was performed in 150 clinically suspected cases which were referred to Radiology Department from OPD, Indoor, Emergency and private sources from outside the hospital. Majority 85(56.7%) were adult males and 65(43.3%) were adult females. The study was divided into two major age groups. There were 33cases (22%) with average age 20-35 years. The other age group 36-50 years had 40(26.7%) Majority of the cases 77(51.3%) were of average >50 years of age. The higher age groups showed a female dominance. Histopathology of 100(66.7%) cases confirmed positive and 50(33.3%) negative for MR Spectroscopy. On comparison of conventional MRI with contrast, and Histopathology it was observed that the sensitivity of MRI was 74.0% and the specificity 82.0%.The positive and negative predictive values gave a lower accuracy rate of 76.6%.

Keeping histopathology as gold standard and comparing the results of MR Spectroscopy the sensitivity of 89.0% and specificity of 96.0% was found to be at a higher diagnostic level as compared to conventional MRI alone. The PPV was 97.8% and NPV was 81.3%. The accuracy of MRS in diagnosis was recorded to be 91.3%. Histopathology grading showed 48 cases to be grade 1 and 52 cases to be grade 2 gliomas. The grading on MRI was similar for 75(50.0%) cases, out of which 15(20.0%) were negative for malignancy. Out of 60 cases studied, 25 cases matched for grade 1 and 35 cases matched for grade 2 tumors. The kappa statistic of 0.248 with p-value <0.001 although significant still showed the matching rate to be too low, i.e.; 50.0% only. When comparison was made for MRS and Histopathology 45 cases matched for grade 1 and 47 cases showed a match for grade 2 tumors. All the remaining 50 cases matched for negative results. The kappa statistics was 0.920 with a p-value < 0.001 and grading matched for 94.70/o cases between MRS and histopathology. The study thus concluded that MRS significantly improves characterization of brain tumors compared to conventional MRI for all diagnostic measures with p-values <0.001.

Table-1: Frequency Distribution of Gender

Gender	Frequency	% age
Male	85	56.7
Female	65	43.3
Total	150	100

Table-2: Frequency Distribution of Age Groups

Age groups	Frequency	% age
20-35 years	33	22.0
36-50 years	40	26.7
>50 years	77	51.3
Total	150	100

Table-3: Frequency Distribution of Brain Tumor on MRI

Brain tumor on MRI	Frequency	% age
Positive	83	55.3
Negative	67	44.7
Total	150	100

Table-4: Frequency Distribution of Brain Tumor on MRS

Brain tumor on MRS	Frequency	% age
Positive	91	60.7
Negative	59	39.3
Total	150	100

Table-5: Frequency Distribution of Brain Tumor on Histopathology

Brain tumor on Histopathology	Frequency	% age
Positive	100	66.7
Negative	50	33.3
Total	150	100

DISCUSSION

Brain tumor is abnormal growth of cancer cells in brain parenchyma. Approximately 1/3rd of brain tumors are metastatic deposits, 1/3rd of them are gliomas and 1/3rd are tumors of non-gliomatous origin. Common presenting symptoms are headache, vomiting, seizures, visual, speech and behavior changes or balance disturbances. Radiologists play an essential role in diagnosis and management of brain tumors and must keep them updated with recent advances and developments in the radiology and utilize newly developed techniques to provide maximum and accurate information to treating physicians and surgeons. This in turns results in improved patient care and prognosis. Conventional MRI is important for the evaluation of brain tumors but in few situations, it does not turn out to be appropriate for differentiating between types

of tumors and in detecting grade of the tumor[4]. Further many non-tumorous lesions may look similar to brain tumors. These include infections like toxoplasmosis, mass-like peripherally enhancing lesion in tumefactive form of multiple sclerosis and sometimes an abscess mimicking a metastatic deposit. Confusing results given by the MRI, makes the way for the use of MRS. Moller- Hartmann et al [5] is a study of mass lesions noted an improvement from 55 to 70% in accuracy of diagnosis when MRS was added. The use of invasive techniques like biopsy, which considered being gold standard for brain tumor evaluation, can be reduced by the use of MRS[6]. MRS also helps in knowing the type of lesions by providing chemical profile of cerebral lesions. Comparing our study results of contrast enhanced MRI with histopathology as gold standard we found that the positive predicted value 89.l 0/o of MRI is close to the studies done by Mahmud et al[7]. MRI showed a sensitivity of 74.0% and specificity of 82.0% for the detection of brain lesions whereas diagnostic accuracy was 76.6%. Law et.a1[8]. In their study showed results for the determining high-grade glioma by using conventional MRI. The values noted for sensitivity and positive predictive value (72.5%, 86.1%) were comparable with those recorded in our study (74.0%, 89.1%) but the values of specificity and negative predictive value (65.0%, 44.0%) were quite low as compared to the ones noted in our study (82.0%, 61.1%). The role of MRS is detecting different neurological and neurosurgical disorders is increasing. Mahmud et al. in their study found the specificity and sensitivity of 84 and 75% respectively for MRI that is comparable with our results. It was seen that added MR Spectroscopy sequence can improve the diagnostic accuracy of brain tumors[7]. Jesrani et al. in their study documented the sensitivity 87.5%, specificity 93.3%, positive predictive value 95.5%, negative predictive value 89.7% and accuracy was 92.1% with MRS which correlates with the values found in our study[9]. In another study Alam et al. recorded 93.02% sensitivity, 70% specificity, positive predictive value 93.02%, negative predictive value 70% and diagnostic accuracy of 88.67% that is close to accuracy recorded in our study as well[10]. In another study Amin et al. showed comparable results for the sensitivity (90.7%), specificity (94.4%) and diagnostic accuracy (91.5%) with MRS[11]. The results of our study are similar to Lin A et al in their reports[12]. Comparison of MRS with histopathology taken as gold standard the Sensitivity, specificity rate and diagnostic accuracy of MR Spectroscopy were 89.0%, 96.0% and % respectively. While the PPV of MR Spectroscopy in present study was 97.8 % and its NPV was 81.2%. Other studies presented by Dlorme S, Weber M A and Jamal S, Mammon N with brain lesions reported sensitivity for MRS ranged from 79 to 100% and specificity ranged from 74 to 100%. PPV ranged from 92 to 100% and NPV ranged from 60 to 100%[14,15]. The main effect of single voxel MR spectroscopy is that if invasive biopsy procedure could be avoided in patients with brain tumors. For this purpose, high specificity and PPV of MR spectroscopy is desirable to avoid false positive results that might lead the surgeon to unnecessary intervention for neoplasm. In our study the specificity (96.0%) and PPV (97.8%) is quite high.

CONCLUSION

Magnetic Resonance Spectroscopy (MRS) is a precise, non-invasive, safe and convenient imaging modality for the assessment of brain tumors and should be used as an aid to conventional Magnetic Resonance Imaging (MRI) to improve its diagnostic accuracy.

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