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MAGNETIC RESONANCE SPECTROSCOPY OUTPERFORMS CONVENTIONAL MRI IN DIAGNOSING BRAIN TUMORS A COMPARATIVE ANALYSIS

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ABSTRACT

Background: Despite several revolutionary advances in imaging technology, physicians are still unable to obtain findings that are 100 percent reliable. Several limitations have been noted for imaging approaches.

Objective: This study compared the diagnostic accuracy of magnetic resonance spectroscopy with conventional magnetic resonance imaging for brain tumors.

Study Design: A Comparative study

Place and duration of study. The Department Of Medical Imaging Technology Riphah International University Faisalabad Campus From 05-June 2023 To 05-Dec-2023

Methodology This study was carried out at the Department of Medical Imaging Technology Riphah International University Faisalabad campus from 05-June 2023 To 05-Dec-2023 following receiving permission from the institute's ethics committee. The study comprised 154 people, both male and female, who had a clinical suspicion of having a brain tumor. Patients between the ages of 20 and 65 who had symptoms and signs suggestive of brain tumors or had nonspecific results from CT and MRI scans were the participants in this study. The technique used was MR spectroscopy. The collected data were entered into SPSS v23.0, and frequency and percentage were reported for gender, positive MRI and MRS results, histology, and a 95% confidence interval.

Results: A total of 154 individuals were studied. The most prevalent age group was 50 years or above 78(50.6%). Histopathology of 52 (33.7%) negative and 102 (66.2%) patients tested positive for MR Spectroscopy. The findings of MR Spectroscopy were compared to conventional MRI alone. With histology maintained as the gold standard, it was discovered that the sensitivity was 90.0% & specificity of 97.0% were at a higher diagnostic level. The results of the MRI accuracy comparison with the conventional histopathological results were 75% sensitivity and 83% specificity. The MRS method has 90.0% and sensitivity 97%.

Conclusion: Thus, the study found that for all diagnostics measures with p-values <0.001, MRS considerably enhances brain tumor characterization compared to conventional MRI.

Keywords: Diagnostic accuracy, Magnetic resonance spectroscopy, Conventional MRI, Brain tumors

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INTRODUCTION

Intracranial tumors, first neuroectodermal or secondarily from other sites, are enigmatic clinically because of the varying manifestation and clinical presentation that could mimic a wide variety of CNS disorders. According to recent data, intracranial neoplasms are primary brain tumors that account for 51% of all intracranial lesions with an incidence rate of 18. 71/100 000 population in 2011 [1]. T1-weighted MRI is the gold standard in the primary diagnosis of brain tumors because it yields detailed morphologic information. However, there is a tendency for these markers to fail in differentiating between tumor types and grades, potentially bringing about diagnostic uncertainty [2]. The limitations placed with MRI have provoked practitioners to evaluate other imaging modalities that hold promise over MRI, such as magnetic resonance spectroscopy (MRS). MRS is very effective in determining the pathophysiologic nature of brain tissue; therefore, it serves a biochemical interest besides anatomical information that you can get from MRI. [3]. This technique can be beneficial for distinguishing between keratinocyte carcinoma and melanoma and assessing tumor metabolism and response to the therapy [4]. Given these concerns, there is a concern over the reliability of diagnostic conclusions based on imaging. For example, the first-generation MRI does not allow for the differentiation of calcifications and hemorrhages; therefore, making the correct diagnosis is rare [5]. MRS, in contrast, positions the detection of metabolism changes at the molecular level, and hence diagnoses of diverse types of cerebral lesions are precise [6]. This research seeks to establish whether MRS is more accurate than conventional MRI in detecting brain tumors based on clinical suspicion against histopathological results.Therefore, through a comparison of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), this research aims to determine whether MRS can significantly enhance the diagnostic results of brain tumor patients [7]. The evidence could help minimize the biopsy operations, making them less invasive, thus improving patient care and management [8].

METHODOLOGY

This cross-sectional study was performed from November 2023 to April 2024 in the Department of Medical Imaging Technology, Riphah International University, Faisalabad Campus, Pakistan, after obtaining the permission of an ethical committee. In all, 154 subjects with clinical suspicion of brain tumors between 20 and 65 years of age were included in the analysis. Subject participants were patients from the emergency wards and outdoor and indoor clinics. The exclusion criteria were a life expectancy of less than 3 years, prior tumor history, heart pacemaker, and contraindication to MRI. Data was collected using both signed Performa on a bilingual level. MRI investigations were done on General Electric 1. T Magnetic resonance imaging (MRI) sequences: T1 axial, T2 axial, T2 sagittal, FLAIR coronal, and post-contrast. MRS was performed using a single voxel method with point-resolved spectroscopy (PRESS), set at TE/ TR = 135/1500. Data analysis used the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 23. Figures recording frequencies, percentages, sensitivity, specificity, PPV, NPV, and accuracy.

APPROVAL FROM ETHICS COMMITTEE:

This study was conducted after obtaining approval from **the Institutional Ethical Review Board of Riphah International University, Faisalabad Campus (ERB-2023/06/154).** Ethical considerations were strictly followed, ensuring patient confidentiality and adherence to biomedical research guidelines. Informed consent was obtained from all participants, and the study was conducted per the Declaration of Helsinki.

RESULTS

A total of 154 individuals were studied. The most prevalent age group was 50 years or above, 78(50.6), followed by the age group 36 to 50 years, 42(27.27%), and 20 to 35 years, respectively (table 1). Out of all the participants, males were 87(56.49%) and females were 67(43.5%), as shown in **Figure 1**. Histopathology of 52 (33.7%) negative, and 102 (66.2%) patients tested positive for MR Spectroscopy. When conventional MRI was compared to Histopathology and contrast, the results showed that MRI's sensitivity was 75.0% and specificity was 83.0%. When MR Spectroscopy findings were compared to conventional MRI alone, it was discovered that the sensitivity of 90.0% & specificity of 97.0% of the test were more diagnostically sound when Histopathology was used as the gold standard. 98.8% was the PPV, and 82.3% was the NPV. It was shown that MRS had a 92. % diagnostic accuracy rate. The findings of MR Spectroscopy were compared to conventional MRI alone. With histology maintained as the gold standard, it was discovered that the sensitivity was 90.0% & specificity of 97.0% were at a higher diagnostic level. There was an 82% NPV and a 98% PPV. A documented 92 % of diagnoses were made using MRS.MRI accuracy compared to traditional histopathological results: 77% accuracy, 75% sensitivity, 83% specificity, 90% optimistic prediction, 62% pessimistic prediction, and 67% prevalence. A comparison of MRS and Histopathology showed 46 grade 1 and 48 grade 2 malignancies. All 52 remaining cases were negative. Kappa statistics between MRS and histology were 0.921 (p-value < 0.001), and 95% of patients had matched grades. Compared to Histopathology reports, MRS offers 90.0% sensitivity, 97% specificity, 98% positive predictive value, 82% prediction of adverse outcomes, 92% accuracy, and 67% prevalence. 49 grade 1 and 53 grade 2 gliomas were histopathological graded. Of the 75 (49.3%) patients with equivalent MRI grades, 16 (21.0%) had negative malignancy results shown in Table 1 to 2

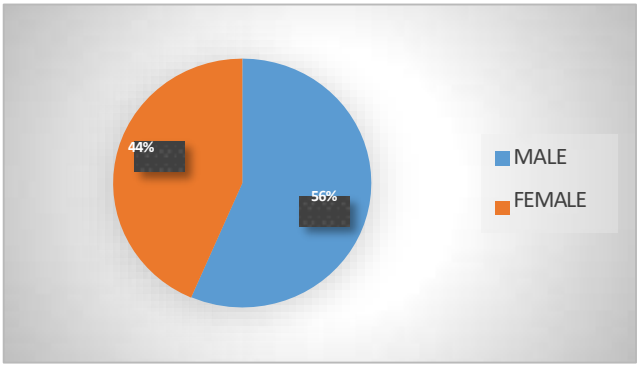
Table 1: Comparison of MRI Findings with Histopathology Reports

MRI Findings	Histopathology Confirmed Tumor	Histopathology Negative for Tumor	Total	p-Value
Positive (Yes)	75	10	85	< 0.001
Negative (No)	27	42	69	
Total	102	52	154	

Table 2: Comparison of MRS Findings with Histopathology Reports

MRS Findings	Histopathology Confirmed Tumor	Histopathology Negative for Tumor	Total	p-Value
Positive (Yes)	90	3	93	< 0.001
Negative (No)	12	49	61	
Total	102	52	154	

Figure 1: Gender Wise Distribution



DISCUSSION

This research establishes that MRS improves the diagnostic precision of brain tumors over plain MRI. The results of the present study are consistent with the earlier findings, suggesting that the use of MRS yields higher sensitivity and specificity in identifying the brain lesion. Initial evaluation of brain tumors has been accomplished mainly with standard MRI because of the superior anatomic information content compared to other imaging modalities. However, there are disadvantages to using it, especially in identifying various types of tumors and their respective grades. For example, an article by Upadhyay and Waldman stated that conventional MRI is functional for initial assessments; however, it cannot characterize tumors with a significant degree of certainty [9]. This limitation provides the rationale for developing other imaging modalities, such as MRS, that provide Metabolite information about tumor metabolism. MRS identifies changes in biochemistry at the molecular level, which gives a chemical signature of the brain lesion. This biochemical aspect augments the detailed structural information from T1- and T2-weighted MRI scans into a more holistic clinical setting. In separate studies, Horská and Barker showed the increased application of MRS in differentiating between benign and malignant masses and evaluating the treatment response [10]. The results of the present work support these findings, illustrating that MRS enhances diagnostic accuracy through having sensitivity and specificity of 90. 0% and 97. 0% respectively. Another study shows that MRS is diagnostically superior

Additional MRS to the conventional MRI improves the diagnostic yield from 55% to 70% for mass lesions [11]. Similarly, Sibtain et al. also observed that with the help of MRS, the tumor types could be adequately differentiated, which is critical in deciding on the correct line of treatment [12]. These previous findings concur with our current MRS investigation, indicating it provides greater diagnostic accuracy over conventional MRI alone. However, the prospect of potentially employing MRS to replace invasive biopsy procedures is one of the most remarkable features. The traditional confirmation method, which often involves histopathological examination, has some associated risks, such as surgical intervention[13]. Based on the experience of using MRS for diagnostics, avoiding or reducing these risks through accurate and non-invasive assessment of the state of specific organs and tissues is possible. Mahmud et al. mentioned MRI specificity and sensitivity as 84% and 75%, respectively, which is relatively close to our MRI findings but still lower in comparison to the MRI results we have in our study. According to Lord et al, MRS helps identify tumors and grading, as from the chemical profile provided in the survey. Conventional MRI provided a specificity of 65. 0 % and a negative predictive value of 44. 0 %, whereas the figures concerning MRS were considerably worse. Our study shows that overall, MRS is more specific (97%) and has a higher NPV (82%) than CT and MRI, making it a better tool for diagnosing brain tumors. Our results are in concordance with the previously published studies, which validate the reliability of MRS as an

Advanced diagnostic technology. For instance, Jesrani et al., who also compared the effectiveness of MRS with the gold standard, achieved a sensitivity of87. 5% and a specificity of 93. 3%, which is quite similar to our findings [14]. Similarly, Alam et al. and Amin et al. illustrated high diagnostic accuracy of MRS with sensitivity and specificity rates, which are our findings [15,16]. Lastly, as evident from the above comparative analysis, it is possible to substantiate the superiority of MRS for diagnosing brain tumors compared to conventional MRI. The improvements made to the sensitivity, specificity, and overall diagnostic capability of MRS are some of the benefits that advocate for the routine use of the technique in studying brain tumors. In addition to enhancing diagnostic certainty, this development could help minimize the utilization of invasive methods in patient diagnosis, which would be advantageous to patient care and treatment[17].

CONCLUSION

The study found that all of the diagnostics measures with p-values <0.001 of magnetic resonance spectroscopy considerably enhance brain tumor characterization compared to conventional MRI.

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Authors Contribution

Concept & Design of Study: Muhammad Aneeque

Drafting: Haider1, Saram Javed,

Data Analysis: Muhammad Awais

Critical Review: Murad Ali

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