

Diagnostic Validity of Magnetic Resonance Imaging for the Detection of Ependymoma among Bangladeshi Children

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Abstract

Background: Detection of ependymoma is very essential for the management of the patients. **Objective:** The purpose of the present study was to validate as well as to find out the Magnetic Resonance Imaging (MRI) findings of ependymoma among paediatric patients. **Methodology:** This cross-sectional study was carried out from January 2010 to June 2011 for a period of one year and six months in the Department of Radiology & Imaging at Dhaka Medical College, Dhaka, Bangladesh. Pediatric Patients having clinically suspected brain tumours of ependymoma variant who were undergone MRI of brain were included in this study. The pediatric patients clinically suspected for brain tumor in posterior cranial fossa region with the suspicion of ependymoma having no contraindication for MRI was underwent MRI examination. The postoperative resected tissues were examined histopathological in the respective department. All the clinical profiles and demographic data were collected. **Result:** This study included 33 patients with clinical features compatible with posterior fossa tumors. Out of all cases 4 cases were diagnosed as ependymoma in MRI and confirmed by histopathological evaluation. Out of 4 histologically proved cases, all cases were in ventricle. However, 2 cases were hypointense and 2 cases were isointense in T1WI and 3 cases were hyperintense in T2WI. 3 cases are solid and 1 case was mixed. All cases had irregular margin and mass effect. All cases also had peri-lesional oedema. Marked enhancement was present in 3 cases. The sensitivity of MRI for the detection of ependymoma was 75.0% (95% CI 19.41% to 99.37%). However, the specificity of MRI was very high which was 96.5% (95% CI 82.24% to 99.91%). The positive predictive values and negative predictive value of MRI were 75.0% (95% CI 28.73% to 95.71%) and 96.5% (95% CI 83.66% to 99.35%) respectively. The accuracy was 93.9% (95% CI 79.77% to 99.26%). **Conclusion:** In conclusion accuracy of MRI for the detection of ependymoma is very high. [Journal of National Institute of Neurosciences Bangladesh, July 2021;7(2):147-151]

Keywords: Diagnostic validity; magnetic resonance imaging; ependymoma; Bangladeshi children

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Introduction

Different type of posterior fossa tumor occurs in different area among children and cerebellar astrocytomas

comprises about one third, medulloblastomas about one quarter, brain stem gliomas about one quarter and ependymomas about one eighth¹. Ependymoma is the 3rd

most common pediatric brain tumor and infratentorial ependymoma occurs in 60.0% to 73.0% patients² and more than 90.0% cases of posterior fossa tumors located in the 4th ventricle³.

Solid portions of ependymoma typically are iso intense to hypo intense relative to white matter on short recovery time/echo time (TR/TE) T1WI⁴. The tumor is hyper intense to white matter on long TR/TE T2-WI and as many as 50.0% cases of ependymomas demonstrate signal heterogeneity which may indicate calcification, necrosis, methemoglobin, hemosiderin⁵. Moderate enhancement following contrast administration is typical⁶.

MRI is helpful in determining the location and size of tumor and planning surgery⁷. Soft tissue contrast is better with MRI than other imaging techniques. MR images can be acquired with equal clarity in any orientation: axial, sagittal, coronal or oblique. Image artifacts from bones are absent with MRI. MRI does not involve exposure to ionizing radiation and has no known significant side effect⁸. MRI without contrast can be done during pregnancy if necessary. MRI and paramagnetic contrast agent have revolutionized the imaging of intracranial conditions. The superiority of MRI over CT-scan is well known and in the literature, but the adequacy of the two methods has rarely been compared⁹.

Magnetic resonance imaging (MRI) is the primary imaging modality used for the assessment of both intracranial and spinal ependymoma¹⁰. Although computed tomography (CT) provides better demonstration of small or subtle calcifications within tumors, MRI provides superior delineation of the extent of tumor due to its greater soft tissue contrast, multiplanar imaging capability, and ability to obtain complementary information with T1- and T2-weighted sequences¹¹. MRI avoids the use of ionizing radiation, a desirable strategy in children who are more susceptible to radiation-induced malignancy than adults¹². The purpose of the present study was to validate as well as to find out the Magnetic Resonance Imaging (MRI) findings of ependymoma among paediatric patients.

Methodology

This study was cross-sectional study. The study period was from January 2010 to June 2011 for a period of one year and six months. This study was carried out in the Department of Radiology & Imaging at Dhaka Medical College, Dhaka, Bangladesh with the collaboration of Neurosurgery Department of Dhaka Medical College Hospital, Dhaka. Prior to commencement of this study,

approval of the respective authority for the research protocol was taken. Informed written consents were taken from legal guardians with easily understandable local language. Proper permission and ethical clearance were taken from the department and institute concerned for this study. Pediatric Patients having clinically suspected ependymoma of posterior fossa brain tumours who undergone MRI scans of brain were included in this study. Paediatric patients who were refuse to do the surgery for histopathological examination were excluded from this study. By Purposive sampling technique cases diagnosed clinically as well as by MRI scan and were operated in the department of neurosurgery. The pediatric patients clinically suspected for posterior cranial fossa tumor having no contraindication for MRI was underwent MR examination. Patients were asked and checked for any metallic substance within the body or on the surface of the body. Patients were assured that the examination was not painful or harmful. In case of restlessness children MRI was done after proper sedation. MRI was obtained with 0.3 Tesla, company machine coil. T1-weighted sagittal, coronal & axial scans were obtained first using short TR (40ms) & short TE (25-30ms). T2-weighted coronal and axial, sagittal images were taken using long TR (3500-4000ms) & long TE (120ms). FLAIR images taken where needed. The average time of each examination was 45min, but ranged from 30 -90min. After intravenous injection of 10ml contrast media namely Magnevist (Dimethylglumine diethylenetriamine sodium salt), T1 weighted sagittal, coronal & axial scans were taken immediately. The postoperative resected tissues were examined histopathologically in the respective department and then the collected reports were correlated with findings of MRI. After informing all the necessary information regarding the research study, data were collected in a pre-designed structured data collection sheets. All the relevant collected data were compiled on a master chart first and then organized by scientific calculator and standard appropriate statistical formulae. Percentages were calculated to find out proportion of the findings. The results were presented in tables, Figures, Diagrams. For the validity of the study outcome, sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI scan in the diagnosis of pediatric posterior cranial fossa tumor were calculated out after confirmation of the diagnosis by histopathology. All data were collected and analyzed manually in view of the objective of the study. Then the results were established in a tabulated form.

Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Analyses were performed with SPSS software, versions 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Continuous data that were normally distributed were summarized in terms of the mean, standard deviation, median, minimum, maximum and number of observations. Skewed data were presented in terms of the maximum, upper quartile, median, lower quartile, minimum and number of observations. Categorical or discrete data were summarized in terms of frequency counts and percentages. Sensitivity, specificity and positive and negative predictive values (PPV and NPV) were calculated by comparing the results MRI and histopathological results. Where appropriate, results were reported with 95% confidence intervals. Probability value <0.05 was considered as level of significance.

Results

This study included 33 patients with clinical features compatible with posterior fossa tumors. The age range of the patients was 2 to 18 years and the mean age with SD was 8.64±3.51 years. The maximum number of patients was between 6 to 10 years age group which was 21(63.2%) cases followed by 11 to 15 years and 0 to 5 years which were 9(24.3%) cases and 3(9.1%) cases respectively (Table 1).

Table 1: Age Distribution of Patients (n=33)

| Age Groups | Frequency | Percent |
|----------------|-----------|--------------|
| 0 to 5 Years | 3 | 9.1 |
| 6 to 10 Years | 21 | 63.6 |
| 11 to 15 Years | 9 | 24.3 |
| Total | 33 | 100.0 |

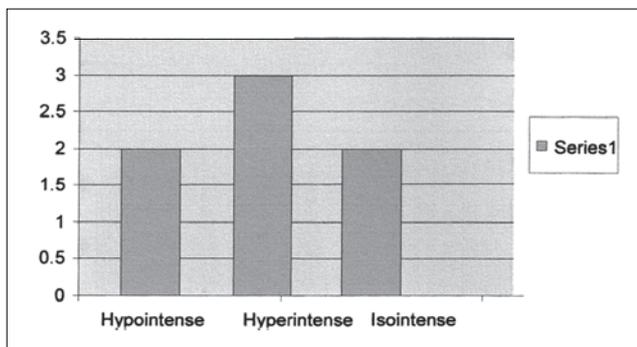


Figure 1: Diagram showing the Intensity of MRI among Patients

MRI findings of Ependymoma: Out of all cases 4 cases were diagnosed as ependymoma in MRI and

confirmed by histopathological evaluation. Rests were diagnosed as other different types of tumors. Out of 4 histologically proved cases, all cases were in ventricle. However, 2 cases were hypointense and 2 cases were isointense in TIWI and 3 cases were hyperintense in T2WI; again, 3 cases were solid and 1 case was mixed. All cases had irregular margin and mass effect. All cases also had peri-lesional oedema. Marked enhancement was present in 3 cases. According to these study findings the following criteria were present to be an ependymoma which were arising from floor of 4th ventricle, strong homogeneous enhancement and extending into the posterior fossa cisterns through foramen of Magendie and foramen of Luschka (Table 2).

Table 2: MRI Findings of Ependymoma among Study Populatio

| MRI Findings | Frequency | Percent |
|----------------------------|-----------|---------|
| Location in Ventricle | 4 | 100.0 |
| Nature | | |
| • Solid | 3 | 75.0 |
| • Mixed | 1 | 25.0 |
| Signal Intensity | | |
| • T1W1-Hypo & Iso | 4 | 100.0 |
| • T2W1-Hyper | 4 | 100.0 |
| • FLAIR-Hyper | 4 | 100.0 |
| Degree of Enhance | | |
| • Strong | 3 | 75.0 |
| • Moderate | 1 | 25.0 |
| Margin | | |
| • Regular | 0 | 0.0 |
| • Irregular | 4 | 100.0 |
| Mass Effect | | |
| • Yes | 4 | 100.0 |
| • No | 0 | 0.0 |
| Peri-lesional edema | | |
| • No | 0 | 0.0 |
| • Yes | 4 | 100.0 |
| State of Ventricle | | |
| • Dilated | 3 | 75.0 |
| • Not Dilated | 1 | 25.0 |

Analysis of MRI and histopathological findings of ependymoma: Out of all patients 4 cases were diagnosed as ependymoma by MRI and 3 cases of them confirmed by histopathological evaluation. They were true positive. One case diagnosed as ependymoma not confirmed by histopathology. It was false positive. Of 29 cases of non ependymoma which were diagnosed by MRI, one case confirmed as ependymoma and 28 cases

were ependymoma by histopathology. They were false negative and true negative respectively (Table 3).

Table 3: Comparison of MRI and Histopathology for the detection of ependymoma

| MRI | Histopathology | | Total | P value |
|--------------|-----------------|------------------|-------------------|---------|
| | Positive | Negative | | |
| Positive | 3(75.0%) | 1(25.0%) | 4(100.0%) | |
| Negative | 1(3.4%) | 28(96.6%) | 29(100.0%) | 0.000 |
| Total | 4(12.1%) | 29(87.9%) | 33(100.0%) | |

The sensitivity of MRI for the detection of ependymoma was 75.0% (95% CI 19.41% to 99.37%). However, the specificity of MRI was very high which was 96.5% (95% CI 82.24% to 99.91%). The positive predictive values and negative predictive value of MRI were 75.0% (95% CI 28.73% to 95.71%) and 96.5% (95% CI 83.66% to 99.35%) respectively. The accuracy was 93.9% (95% CI 79.77% to 99.26%) (Table 4).

Table 4: Diagnostic Validity of MRI for the Detection of ependymoma

| Variables | Values | 95% CI |
|---------------------------|--------|------------------|
| Sensitivity | 75.0% | 19.41% to 99.37% |
| Specificity | 96.5% | 82.24% to 99.91% |
| Positive Predictive Value | 75.0% | 28.73% to 95.71% |
| Negative predictive value | 96.5% | 83.66% to 99.35% |
| Accuracy | 93.9% | 79.77% to 99.26% |

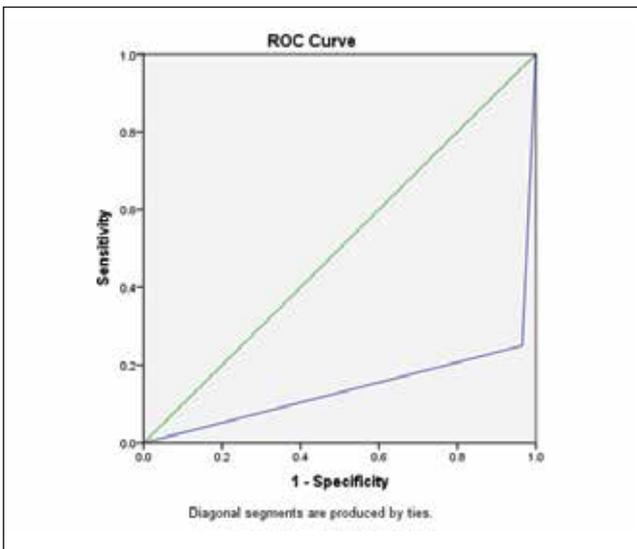


Figure II: Diagram showing the ROC Curve of MRI for the detection of Ependymoma

The area under the curve for the detection of ependymoma by MRI was calculated and was found that it was low (0.142) with the confidence interval of

0.00 to 0.401. However, this was statistically significant (p=0.022) (Table 5).

Table 5: Area Under the Curve of MRI for the Detection of Ependymoma

| AUC Value | P value | 95% CI | |
|-----------|---------|--------|-------|
| | | Lower | Upper |
| 0.142 | 0.022 | 0.000 | 0.401 |

Discussion

Magnetic resonance imaging does not involve exposure to ionizing radiation and has no known significant clinical side effects. Magnetic resonance imaging without contrast can be done during pregnancy if necessary¹³. This study was carried out with an aim to establish the effectiveness of MRI scan in preoperative evaluation of ependymoma and their histopathological correlation of postoperative resected tissue along with its validity tests by calculating sensitivity, specificity, accuracy, positive predictive value, negative predictive value respectively.

Among the brain tumor patients who sought healthcare in the neurosurgery and Radiology department of Dhaka Medical College Hospital, Dhaka, Bangladesh during the period of January 2010 to June 2011 were enrolled in the study. Thirty-three patients of posterior fossa tumors were enrolled in this study.

This study was carried out by 0.3 Tesla MRI with 5 mm slice thickness. This study includes 33 patients who confirmed as pediatric posterior fossa brain tumours. The age range from 2 to 18 years. MRI of brain was performed in all cases and cases were truly diagnosed as posterior fossa tumors. MRI failed to detect two cases though it has strong clinical evidence of posterior fossa brain tumours and histopathologically these two tumors proved as tuberculoma.

In this study the mean age of the patients with pediatric posterior fossa tumors is 8.64±3.51 years, and the maximum number of patients was between 6 to 10 years age group. Regarding pediatric posterior fosse tumors, Wilne et al¹⁴ have shown a review of 200 cases of brain tumors in which mean age at presentation was 7.4 years. Ependymoma is a posterior fossa tumor¹³. Thus it is found in infratentorial region. Likasitwattanakul et al¹⁵ have stated on their study that overall brain tumors are located at the infratentorial region. In the infratentorial regions, medulloblastoma and cerebellar astrocytoma of various grades are the most common tumors in the cerebellum. In another study¹⁶ it has been reported that in children cerebellar astrocytomas comprises about one third, medulloblastomas about one quarter brainstem,

glioma about one quarter and ependymomas about one eighth. But differ from Kadri et al¹⁷ have described that the most common tumor in the childhood population is medulloblastoma (27.5%) followed by astrocytoma (25.8%).

Solid portions of ependymoma typically are isointense to hypointense relative to white matter on T1 weighted images. The tumor hyperintense to white matter on T2-weighted images, shows similar result¹⁸. They are also shows heterogeneous signal intensity, which may indicate calcification, necrosis, methemoglobin, hemosiderin, or tumor vascularity. In this study out of 5 brainstem glioma 4 tumors diagnosed by MRI as brain stem glioma and one tumor is misdiagnosed. These solid tumors are iso to hypointense on TIWI and most case hyperintense, mild contrast enhancement seen in these tumour. These findings are almost similar to the results of other studies^{11,19}.

The sensitivity of MRI for the detection of ependymoma was 75.0% (95% CI 19.41% to 99.37%). However, the specificity of MRI was very high which was 96.5% (95% CI 82.24% to 99.91%). The positive predictive values and negative predictive value of MRI were 75.0% (95% CI 28.73% to 95.71%) and 96.5% (95% CI 83.66% to 99.35%) respectively. The accuracy was 93.9% (95% CI 79.77% to 99.26%). Colosimo et al⁶ have mentioned the accuracy in detection and identification of posterior fossa tumor about 96.0%. This result strongly supports the present study.

Conclusion

In conclusion all cases of ependymoma are found in ventricle. However, both hypointense and isointense are found in TIWI and hyperintense in T2WI. Furthermore, majority are solid tumor with irregular margin and mass effect as well as peri-lesional oedema. The sensitivity of MRI for the detection of ependymoma is low, but the specificity is high. However, the area under the curve is low. Therefore, a large scale study should be conducted to see the real scenario.

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