

## Original Article

## Comparison of Test Validity of Magnetic Resonance Imaging in the Diagnosis of Different Grades of Astrocytoma

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## Abstract

Accurate detection of astrocytomas is very difficult. The purpose of the present study was to evaluate the usefulness of MRI in detection of intracranial astrocytoma. This cross-sectional study was conducted at the Department of Radiology and Imaging with the collaboration of Department of Neurosurgery and Department of Pathology at Sir Salimullah Medical College (SSMC & MH), Dhaka from January 2013 to December 2013 for a period of one year. All the clinically suspected and CT scan diagnosed cases of intracranial astrocytoma patients of any age of both sexes were included as study population. All cases having no contraindication for MRI underwent MR examination. MR imaging was obtained with 0.5 Tesla machine (SIEMENS). The postoperative resected tissues were examined histopathological in the respective department. Then the collected reports were compared with findings of MRI. The sample size of the present study was 48 astrocytoma patients. The highest sensitivity was found in grade III astrocytoma (90.5%) followed by grade II (85.7%) grade IV (75.0%) and grade I (60.0%). The highest specificity was found in grade I astrocytoma (97.7%) followed by Grade III (96.3%), grade IV (92.5%) and grade II (91.5%). The highest accuracy was found in both grade I astrocytoma (93.7%) and grade III (93.7%) followed by grade II (92.5%) and grade IV (89.6%). In the conclusion, MRI is an effective tool for the diagnosis of

astrocytoma. MRI has a high diagnostic validity for the detection of different grades of astrocytoma.

**Key words:** Magnetic Resonance Imaging; astrocytoma; validity test.

## INTRODUCTION

Brain tumors account for 85.0% to 90.0% of all primary central nervous system (CNS) tumors<sup>1</sup>. Plain radiograph was previously used in the past to detect intracranial tumour. Cerebral angiography and pneumocephalography were also done; however, none of which was conclusive<sup>2</sup>. With the advent of CT and MRI there is revolutionary change in the detection of intracranial tumour. MRI scan has made a significant impact on the differential diagnosis of intracranial tumours<sup>3</sup>.

Compared with CT, MRI offers greater contrast resolution, including greater sensitivity for the detection of subacute and chronic haemorrhage in association with tumours and other lesions of brain<sup>4</sup>. MRI lacks ionizing radiation. Delineation of posterior cranial fossa soft tissue anatomy is better visualized with MRI than CT as because MRI lacks beam-hardening artefact<sup>5</sup>. Accuracy of lesion localization on MRI is enhanced by its direct multiplanar capability<sup>6</sup>. MRI provides important information regarding contrast material enhancement, peritumoural oedema, distant tumour foci, haemorrhage, necrosis, mass effect and so on, which are all helpful in characterizing tumour aggressiveness and hence tumour grade<sup>7</sup>. In this context this present study was undertaken to evaluate the usefulness of MRI in detection of intracranial astrocytoma.

## METHODOLOGY

This study was designed as cross sectional study which was carried out in the Department of Radiology and Imaging with the collaboration of Department of Neurosurgery and Department of Pathology at Sir Salimullah Medical College (SSMC & MH), Dhaka from January 2013 to December 2013 for a period of one (1) year. A total number of 48 astrocytoma patients were evaluated by purposive sampling technique. Patients who were clinically suspected and CT scan diagnosed cases of intracranial astrocytomas referred to Radiology and Imaging department of Dhaka Medical college Hospital (DMCH) either from OPD or from indoor of DMCH for MRI of brain were included in this study.

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Prior to the commencement of this study, the research protocol was approved by the ethical committee (Local Ethical committee) of SSMC. All cases having no contraindication for MRI underwent MR examination. Patients were asked for or checked for any metallic or harmful. MR imaging was obtained with 0.3 Tesla machine (HITACHI). T1W image in axial, sagittal and coronal plane were obtained using short TR (500-800ms) and short TE (14-20ms). T2W image in axial and coronal plane were obtained using long TR (3500-4500ms) and long TE (80ms). FLAIR images were also taken. Contrast MRI studies using intravenous Gd-DTPA (Magnevist, 0.1 mmol/Kg) with axial, coronal and sagittal T1W scan were performed in all cases. The average time of examination was 45 minutes but ranges from 30-90 minutes. Slice thickness was 5-6 mm with a field of view 230x230 mm and pictures matrix was 256x256 or 192x256. The postoperative resected tissues were examined histopathological in the respective department. MRI scan findings were compared with histopathological reports. Then the collected reports were compared with findings of MRI. Data were collected using a preformed data collection sheet. Base line information was collected from the patient after exploration of different complaints and sign and symptoms. All information regarding clinical features and histopathological results were recorded in a data collection sheet. Statistical analysis was performed by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-17), 95% confidence limit was taken.

**RESULTS**

**Table 1: Comparison of MRI findings with Histopathological Findings during Diagnosis of Grade I Astrocytoma (n=48)**

MRI Diagnosis	Histopathological Diagnosis		Total
	Positive	Negative	
Test Positive	3	1	4
Test Negative	2	42	44
<b>Total</b>	<b>5</b>	<b>43</b>	<b>48</b>

Table 1 shows the comparison of MRI findings with Histopathological Findings during diagnosis of Grade I Astrocytoma. Both histopathological and MRI positive astrocytoma case is found in 3 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 42 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 1 case which is known as false positive.

**Table 2: Comparison of MRI findings with Histopathological Findings during diagnosis of Grade II Astrocytoma (n=48)**

MRI Diagnosis	Histopathological Diagnosis		Total
	Positive	Negative	
Test Positive	12	3	15
Test Negative	2	31	33
<b>Total</b>	<b>14</b>	<b>34</b>	<b>48</b>

Table 2 shows the comparison of MRI findings with Histopathological Findings during diagnosis of Grade II Astrocytoma. Both histopathological and MRI positive astrocytoma case is found in 12 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 31 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 3 case which is known as false positive.

**Table 3: Comparison of MRI findings with Histopathological Findings during diagnosis of Grade III Astrocytoma (n=48)**

MRI Diagnosis	Histopathological Diagnosis		Total
	Positive	Negative	
Test Positive	19	1	20
Test Negative	2	26	28
<b>Total</b>	<b>21</b>	<b>27</b>	<b>48</b>

Table 3 shows the comparison of MRI findings with Histopathological Findings during diagnosis of Grade III Astrocytoma. Both histopathological and MRI positive astrocytoma case is found in 19 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 26 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 1 case which is known as false positive.

**Table 4: Comparison of MRI findings with Histopathological Findings during diagnosis of Grade IV Astrocytoma (n=48)**

MRI Diagnosis	Histopathological Diagnosis		Total
	Positive	Negative	
Test Positive	6	3	9
Test Negative	2	37	39
<b>Total</b>	<b>8</b>	<b>40</b>	<b>48</b>

Table 4 shows the comparison of MRI findings with Histopathological Findings during diagnosis of Grade IV Astrocytoma. Both histopathological and MRI positive astrocytoma case is found in 6 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 37 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 3 cases which is known as false positive.

**Table 5: Validity of MRI during diagnosis of Different Grades of Astrocytoma**

Validity	Different Grades (95% CI)			
	Grade I	Grade II	Grade III	Grade IV
Sensitivity	60.0%(46.1-73.9%)	85.7% (56.1-97.2%)	90.5%(68.2-98.3%)	75.0%(62.7-87.2%)
Specificity	97.7%(93.5-101.9%)	91.2% (75.2-97.2%)	96.3%(79.1-99.8%)	92.5%(85.5-99.9%)
PPV	75.0%(62.7-87.2%)	80.0%(51.4-94.7%)	95.0%(73.0-99.7%)	66.7%(53.4-80.0%)
NPV	95.4%(89.5-101.3%)	93.9%(78.4-98.9%)	92.9%(75.0-98.7%)	94.9%(88.7-101.1%)
Accuracy	93.7%(86.8-100.6%)	90.0%(81.5-98.49%)	93.7%(86.8-100.6%)	89.6%(81.0-98.2%)

\*PPV= Positive Predictive Value; NPV= Negative Predictive value

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade I were 60.0%(95% CI 46.1-73.9%), 97.7% (95% CI 93.5-101.9%), 75.0% (95% CI 62.7-87.2%), 95.4%(95% CI 89.5-101.3%) and 93.7%(95% CI 86.8-100.6%) respectively. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade II were 85.7% (95% CI 56.1-97.2%), 91.2% (95% CI 75.2-97.2%), 80.0% (95% CI 51.4-94.7%), 93.9% (95% CI 78.4-98.9%) and 90.0% (95% CI 81.5-98.49%) respectively. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade III were 90.5% (95% CI 68.2-98.3), 96.3% (95% CI 79.1-99.8%), 95.0% (95% CI 73.0-99.7%), 92.9% (95% CI 75.0-98.7%) and 93.7% (95% CI 86.8-100.6%) respectively. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade IV were 75.0% (95% CI 62.7-87.2%), 97.7% (95% CI 85.5-99.9%), 75.0% (95% CI 53.4-80.0%), 95.4% (95% CI 88.7-101.1%) and 93.7%(95% CI 81.0-98.2%) respectively. The highest sensitivity was found in grade III astrocytoma (90.5%) followed by grade II (85.7%), grade IV (75.0%) and grade I (60.0%). The highest specificity was found in grade I astrocytoma (97.7%) followed by grade III (96.3%), grade IV (92.5%) and grade II (91.5%). The highest Accuracy was found in grade I astrocytoma (93.7%) and grade III (93.7%) followed by grade II (92.5%) and grade IV (89.6%) (Table 5).

## DISCUSSION

The comparison of MRI findings with histopathological findings during diagnosis of Grade I Astrocytoma is recorded. Both histopathological and MRI positive astrocytoma case is found in 3 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 42 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 1 case which is known as false positive. The validity of MRI during diagnosis of Grade I astrocytoma is recorded. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade I are 60.0% (95% CI 46.1-73.9%), 97.7% (95% CI 93.5-101.9%), 75.0% (95% CI 62.7-87.2%), 95.4% (95% CI 89.5-101.3%) and 93.7% (95% CI 86.8-100.6%) respectively. The comparison of MRI findings with histopathological findings during

diagnosis of Grade II astrocytoma is recorded. Both histopathological and MRI positive astrocytoma case is found in 12 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 31 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 3 case which is known as false positive. The validity of MRI during diagnosis of Grade II astrocytoma is recorded. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade II are 85.7% (95% CI 56.1-97.2%), 91.2% (95% CI 75.2-97.2%), 80.0% (95% CI 51.4-94.7%), 93.9% (95% CI 78.4-98.9%) and 90.0% (95% CI 81.5-98.49%) respectively. Similar findings are reported by Chishty et al<sup>7</sup> and have mentioned that sensitivity of MRI in detection of low grade gliomas is 100.0%.

The comparison of MRI findings with histopathological findings during diagnosis of Grade III astrocytoma is recorded. Both histopathological and MRI positive astrocytoma case is found in 19 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 26 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 1 case which is known as false positive. The validity of MRI during diagnosis of Grade III astrocytoma is recorded. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade III are 90.5% (95% CI 68.2-98.3), 96.3% (95% CI 79.1-99.8%), 95.0% (95% CI 73.0-99.7%), 92.9% (95% CI 75.0-98.7%) and 93.7% (95% CI 86.8-100.6%) respectively. Similarly Chishty et al<sup>7</sup> has reported that sensitivity of MRI for the detection of grade III is 95% which are close to the results of present study.

The comparison of MRI findings with histopathological findings during diagnosis of Grade IV astrocytoma is recorded. Both histopathological and MRI positive astrocytoma case is found in 6 cases which indicate true positive. Again, both histopathological and MRI negative astrocytoma case is found in 37 cases which indicate true negative. Histopathological positive but MRI negative case is found in 2 cases which is known as false negative. Histopathological negative but MRI positive case is found in 3 cases which is known as false positive. The validity of MRI during diagnosis of Grade IV astrocytoma is recorded. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI for the diagnosis of astrocytoma grade IV are 75.0% (95% CI 62.7-87.2%), 97.7% (95% CI 85.5-99.9%), 75.0% (95% CI 53.4-80.0%), 95.4% (95% CI 88.7-101.1%) and 93.7% (95% CI 81.0-98.2%) respectively. Similar to the present study Law et al<sup>8</sup> observed that PPV and NPV of MRI for determination of a high grade glioma were 86.1% and 44.1% respectively which is consistent with the present study.

Comparison of sensitivity of MRI for the diagnosis of different grade of astrocytoma is analyzed. The highest sensitivity was found in grade III astrocytoma (90.5%) followed by Grade II (85.7%) grade IV (75.0%) and grade I (60.0%). It is interesting that during comparison this result shows that sensitivity of the MRI for the detection of astrocytoma is decreased after increasing of grade of the tumour. Similar to the present findings Ellika et al<sup>9</sup> has

reported that sensitivity is 85.7% for different grading of astrocytomas with conventional MRI which is very close to the results of present study.

The comparison of specificity of MRI for the diagnosis of different grade of astrocytoma is recorded. The highest specificity was found in grade I astrocytoma (97.7%) followed by Grade III (96.3%), grade IV (92.5%) and grade II (91.5%). These findings are clearly shown that the specificity of MRI for the detection of astrocytoma is very high and all are more than 90.0% which is very useful during diagnosis of astrocytoma. Law et al<sup>8</sup> found sensitivity of glioma grading ranging from 55.1% to 83.3%. Ellika et al<sup>9</sup> found that sensitivity for different grading of astrocytoma is 60.0% which is similar to the present study. Law et al<sup>8</sup> observed specificity of MRI in the diagnosis of high grade gliomas was 65% and in Riemann et al<sup>10</sup> series it was 80.0% in diagnosing low grade gliomas which is consistent with the present study. During diagnosis the specificity is very important for the detection of the disease state<sup>11,12</sup>.

The comparison of accuracy of MRI for the diagnosis of different grade of astrocytoma is analyzed. The highest accuracy was found in both grade I astrocytoma (93.7%) and grade III (93.7%) followed by grade II (92.5%) and grade IV (89.6%). Accuracy of MRI for the detection of astrocytoma is very much effective and in all grade of tumor it is more than or equal to 90.0%. This indicates that MRI is very much useful for the detection of different grades of astrocytoma. Similar to this result Chishty et al<sup>7</sup> found 94.0% accuracy of preoperative MRI grading of intracranial astrocytomas. Again Riemann et al<sup>10</sup> found 88.0% accuracy of contrast enhanced MRI for detecting intracranial astrocytomas which is very consistent with the present study. From the results of present study as well as the findings obtained by others like Riemann et al<sup>10</sup>, Ellika et al<sup>9</sup> and Chishty et al<sup>7</sup>, it is conceivable that MRI scan is a highly accurate and sensitive modality in the evaluation of intracranial astrocytomas.

## CONCLUSION

In conclusion, the findings of this study permit to conclude that MRI is an effective tool for the diagnosis of different grades of astrocytoma. Sensitivity, specificity and accuracy of MRI for the diagnosis of astrocytoma are high in different grades of astrocytoma. Nationwide further large scale study should be carried out.

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