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Original Research

Assessment of role of perfusion MRI in evaluation of brain tumours by using relative Cerebral Blood Volume

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ABSTRACT

Background: One of the main causes of neurological issues is still brain tumors. The age-standardized incidence of malignancies of the central nervous system rose 17.3% between 1990 and 2016. The present study was conducted to assess role of perfusion MRI in evaluation of brain tumours by using relative Cerebral Blood Volume (r CBV).

Materials & Methods: 43 cases of brain tumour of both genders was selected. MRI was performed on 23 patients using conventional imaging, perfusion imaging with T2*-weighted Echo-Planar sequence after administration of Gadopentetate dimeglumine. Perfusion data was processed to obtain colour maps and rCBV value was generated. rCBV values were correlated with histopathological grade of tumours.

Results: Out of 43 patients, 23 were males and 20 were females. Common brain tumor was astrocytoma in 30 and medulloblastoma in 13. Grade was grade I in 10, grade II in 21, grade III in 7 and grade IV in 5 cases. The difference was significant (P< 0.05). The mean relative Cerebral Blood Volume (rCBV) in grade I was 2.5, in grade II was 4.6, in grade III was 8.1 and grade IV was 13.7. The difference was significant (P< 0.05).

Conclusion: Prior to surgery, perfusion MRI can be used to distinguish between low-grade and high-grade gliomas. Therefore, its incorporation into standard MRI will improve the diagnostic precision in distinguishing between low-grade and high-grade gliomas.

Keywords: Brain tumour, Cerebral blood volume, Medulloblastoma

Introduction

One of the main causes of neurological issues is still brain tumors. The age-standardized incidence of malignancies of the central nervous system rose 17.3% between 1990 and 2016.

There is a great deal of variance in symptoms, so it is crucial to identify these lesions with clarity.[1] For reasons including improved soft tissue contrast distinction, the ability to more clearly show the extent of the tumor and its relationship to surrounding eloquent structures, MRI is thought to be superior to CT. In addition to traditional MR, magnetic resonance perfusion imaging is a method that evaluates different hemodynamic measures noninvasively.[2]

These metrics are Mean Transit Time (MTT), Cerebral Blood Volume (CBV), and Cerebral Blood Flow (CBF). CBV is proportional to area under the contrast agent concentration-time curve.[3] This number is commonly represented as rCBV which refers to measurement relative to standard reference, usually contralateral to white matter. The majority of adult central nervous system (CNS) primary neoplasms are glial in origin.[4] The most prevalent and typically lethal of the glial-originated tumors are glioblastomas. The degree of angiogenesis and vascular architecture are crucial factors in assessing the biological aggressiveness of various tumor forms.[5] In-vivo maps of CBV that show the general vascularity of the tumor are provided by perfusion MRI. rCBV measurements has been shown to correlate with both conventional angiographic assessment of tumour vascularity and histological measurements of tumour neovascularisation.[6] The present study was conducted to assess role of perfusion MRI in evaluation of brain tumours by using relative Cerebral Blood Volume (rCBV).

Materials & Methods

The study was carried out on 43 cases of brain

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tumour of both genders. All gave their written consent to participate in the study.

Data such as name, age, gender etc. was recorded. MRI was performed on 23 patients using conventional imaging, perfusion imaging with T2*-weighted Echo-Planar sequence after administration of Gadopentetate dimeglumine. Perfusion data was processed to obtain colour maps and rCBV value was generated. rCBV values were correlated with histopathological grade of tumours. Results thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

Results

Table: I Distribution of patients

Total- 43		
Gender	**Male**	**Female**
Number	23	20

Table I shows that out of 43 patients, 23 were males and 20 were females.

Table: II Assessment of parameters

Parameters	Variables	Number	P value
Type	Astrocytoma	30	0.01
	Medulloblastoma	13	
Grade	Grade I	10	0.04
	Grade II	21	
	Grade III	7	
	Grade IV	5	

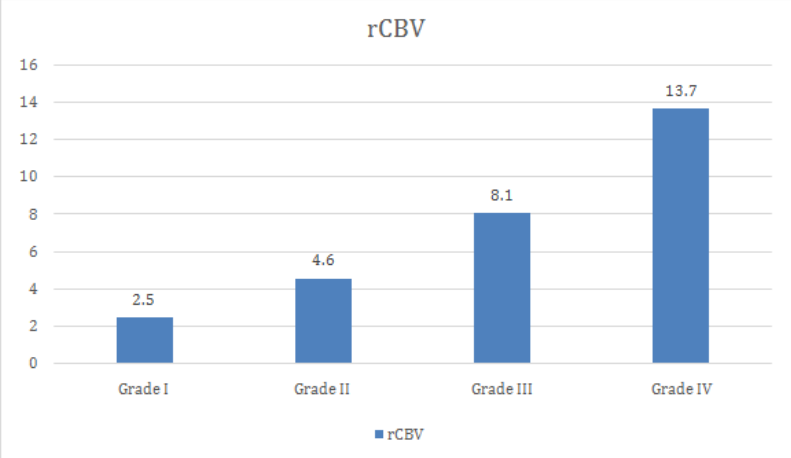
Table II shows that common brain tumor was astrocytoma in 30 and medulloblastoma in 13. Grade was grade I in 10, grade II in 21, grade III in 7 and grade IV in 5 cases. The difference was significant (P< 0.05).

Table III Relative Cerebral Blood Volume (rCBV) based on grading

Grade	R CBV	P value
Grade I	2.5	0.01
Grade II	4.6	
Grade III	8.1	
Grade IV	13.7	

Table III, graph I shows that mean relative Cerebral Blood Volume (rCBV) in grade I was 2.5, in grade II was 4.6, in grade III was 8.1 and grade IV was 13.7. The difference was significant (P< 0.05).

Graph: I Relative Cerebral Blood Volume (r CBV) based on grading



Discussion

The most prevalent brain tumors are gliomas. It can occasionally be challenging to distinguish between low-grade and high-grade gliomas due to their substantial overlap.[7] Perfusion MRI offers in vivo CBV maps that show the general vascularity of the tumor, enabling an indirect evaluation of tumor angiogenesis.[8,9] It has been demonstrated that the magnetic resonance measurement of rCBV correlates with both histological measurements of tumor

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neovascularization and traditional angiographic evaluations of tumor vascular density.[10] The present study was conducted to assess role of perfusion MRI in evaluation of brain tumours by using relative Cerebral Blood Volume (rCBV).

We found that out of 43 patients, 23 were males and 20 were females. Grewal et al[11] evaluated the role of perfusion MRI in evaluation of brain tumours by using relative Cerebral Blood Volume (rCBV). Grade I astrocytoma and Grade II astrocytoma had mean rCBV of 1.435±1.063 and 2.046±1.282, respectively. Grade III astrocytoma and Grade IV astrocytoma had mean rCBV of 7.620±3.463 and 12.455±0.361 respectively. Mean rCBV of medulloblastoma was 4.185±2.482. Low grade astrocytoma (grade I and grade II) had mean rCBV of 1.817±1.207 and high grade astrocytoma (grade III and grade IV) had mean rCBV of 9.554±3.611. There was significant difference between mean rCBV in Grade I/II vs III/IV ($p<0.001$), there was no significant difference between mean rCBV in Grade I and Grade II.

We found that common brain tumor was astrocytoma in 30 and medulloblastoma in 13. Grade was grade I in 10, grade II in 21, grade III in 7 and grade IV in 5 cases. Law M et al[12] evaluated the sensitivity, specificity, PPV, and NPV of perfusion MR imaging and MR spectroscopy compared with conventional MR imaging in grading primary gliomas. One hundred sixty patients with a primary cerebral glioma underwent conventional MR imaging, dynamic contrast-enhanced T2*-weighted perfusion MR imaging, and proton MR spectroscopy. Gliomas were graded as low or high based on conventional MR imaging findings. The rCBV measurements were obtained from regions of maximum perfusion. Metabolite ratios (choline [Cho]/creatine [Cr], Cho/N-acetylaspartate [NAA], and NAA/Cr) were measured at a TE of 144 ms. Tumor grade determined with the three methods was then compared with that from histopathologic grading. Logistic regression and receiver operating characteristic analyses were performed to determine optimum thresholds for tumor grading. Sensitivity, specificity, PPV, and NPV for identifying high-grade gliomas were also calculated. Sensitivity, specificity, PPV, and NPV for determining a high-grade glioma with conventional MR imaging were 72.5%, 65.0%, 86.1%, and 44.1%, respectively. Statistical analysis demonstrated a threshold value of 1.75 for rCBV to provide sensitivity, specificity, PPV, and NPV of 95.0%, 57.5%, 87.0%, and 79.3%, respectively. Threshold values of 1.08 and 1.56 for Cho/Cr and 0.75 and 1.60 for Cho/NAA provided the minimum C2 and C1 errors, respectively, for determining a high-grade glioma. The combination of rCBV, Cho/Cr, and Cho/NAA resulted in sensitivity, specificity, PPV, and NPV of 93.3%, 60.0%, 87.5%, and 75.0%, respectively. Significant differences were noted in the rCBV and Cho/Cr, Cho/NAA, and NAA/Cr ratios between low- and high-grade gliomas (P <.0001,.0121,.001, and.0038, respectively).

We found that mean relative Cerebral Blood Volume (rCBV) in grade I was 2.5, in grade II was 4.6, in grade III was 8.1 and grade IV was 13.7. Saini J et al[13] assessed the inter-technique agreement of relative cerebral blood volume (rCBV) measurements obtained using T1- and T2*-perfusion MRI on 3T scanner in glioma patients. Qualitative analysis of the conventional and perfusion images showed that 16/49 (32.65%) tumors showed high susceptibility, and in these patients T2*-perfusion maps were suboptimal. Bland-Altman plots revealed an agreement between two independent observers recorded rCBV values for both T1- and T2*-perfusion. The ICC demonstrated strong agreement between rCBV values recorded by two observers for both T2* (ICC = 0.96, p = 0.040) and T1 (ICC = 0.97, p = 0.026) perfusion and similarly, good agreement was noted between rCBV estimated using two methods (ICC = 0.74, P<0.001). ROC analysis showed that rCBV estimated using T1- and T2*-perfusion methods were able to discriminate between grade-III and grade-IV tumors with AUC of 0.723 and 0.767 respectively. Comparison of AUC values of two ROC curves did not show any significant difference.

The shortcoming of the study is small sample size.

Conclusion

Authors found that prior to surgery, perfusion MRI can be used to distinguish between low-grade and high-grade gliomas. Therefore, its incorporation into standard MRI will improve the diagnostic precision in distinguishing between low-grade and high-grade gliomas.

References

1. Shin JH, Lee HK, Kwun BD, Kim JS, Kang W, Choi CG, et al. Using relative cerebral blood flow and volume to evaluate the histopathologic grade of cerebral gliomas: Preliminary results. AJR. 2002;179(3):783-89.
2. Aronen HJ, Gazit IE, Louis DN, Buchbinder BR, Pardo FS, Weisskoff RM, et al. Cerebral blood volume maps of gliomas: Comparison with tumour grade and histologic findings. Radiology. 1994;191(1):41-51.
3. Shoaib Y, Nayil K, Makhdoomi R, Asma A, Ramzan A, Shaheen F, et al. Role of diffusion and perfusion magnetic resonance imaging in predicting the histopathological grade of gliomas- A prospective study. Asian Journal of Neurosurgery. 2019:14(1):47-51.
4. Abrigo JM, Fountain DM, Provenzale JM, Law EK, Kwong JSW, Hart MG, et al. Magnetic resonance perfusion for differentiating low grade from high grade gliomas at first presentation (review). Cochrane Database Syst Rev. 2018;1(1):CD011551.
5. Ghodsi SM, Khoshnevisan A, Arjipour M, Ghanaati H, Firouznia K, Jalali AH, et al. Diagnostic efficacy of Perfusion Magnetic Resonance Imaging in Supratentorial Glioma Grading. Iran J Radiol. 2018;15(2):e13696.

DOI: 10.69605/ijlbpr_14.3.2025.167

6. Kudo K, Uwano I, Hiari T, Murakami R, Nakamura H, Fujima N, et al. Comparison of different post-processing algorithms for dynamic susceptibility contrast perfusion imaging of cerebral gliomas. Magn Reson Med Sci. 2017;16(2):129-36.
7. Abe T, Mizobuchi Y, Nakajima K, Otomi Y, Irahara S, Obama Y, et al. Diagnosis of brain tumours using contrast-enhanced perfusion imaging with a short acquisition time. Springerplus. 2015; 4:88.
8. Heiss WD, Raab P, Lanfermann H. Multimodality assessment of brain tumours and tumour recurrence. J Nucl Med. 2011;52(10):1585-600.
9. Cha S, Knopp E A, Johnson G, Wetzel SG, Litt AW, Zagzag D. Intracranial mass lesions: Dynamic contrast-enhanced susceptibility-weighted echo-planar perfusion MR imaging. Radiology. 2002;223(1):11-29.
10. Stupp R, Mason WP, Van Den Bent MJ, Weller M, Fisher B, Taphoorn MJ, et al. Radiotherapy plus concomitant and adjuvant temozolomide for glioblastoma. N Engl J Med. 2005;352(10):987-96.
11. Burger PC, Vogel FS. The brain tumours: In Burger PC, Vogel FS eds. Surgical pathology of central Nervous System and its coverings. New York: Willey. 1982;223-66.
12. Law M, Yang S, Wang H, Babb JS, Johnson G, Cha S, et al. Glioma grading: Sensitivity, specificity and predictive values of MR imaging and proton MR spectroscopic imaging compared with conventional MR imaging. Am J Neuroradiol. 2003;24(10):1989-98.
13. Saini J, Gupta RK, Kumar M, Singh A, Saha I, Santosh V, et al. Comparative evaluation of cerebral gliomas using rCBV measurements during sequential acquisition of T1-perfusion and T2*-perfusion MRI. Plos One. 2019;14(4):e0215400