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Role of CT Perfusion in Differentiation between High and Low Grade Glioma

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Abstract

Gliomas, the most common primary brain neoplasms in adults, are very heterogeneous tumors. High-grade gliomas can be highly invasive and extremely vascular tumors. (1)

Glioma grading is currently based on the histopathologic assessment of the tumor, which is achieved by stereotactic brain biopsy or cytoreductive surgery; and there are inherent limitations with these techniques and their interpretation. (1)

Therapeutic approaches, response to therapy, and prognosis depend on accurate grading, and thus finding the part of the tumor with the highest grade to be biopsied is critical. (1)

The aim of this study was to evaluate role of CT perfusion in differentiation between low grade and high grade glioma

Methods: *This is study was conducted on 32 patients from 2012 to 2013.All patients were examined by CT perfusion*

The patients were subjected to surgery and pathological analysis, then correlation between CT results and pathological analysis was done.

Results: *In our study mean CBV for high and low grade glioma was 11.5ml/100gm and 0.36ml/100gm respectively with statistically significant value between two groups (P value= .037), the cut of value in was 2.9 ml /100gm with sensitivity 91% and specificity 100%.The CBF for high grade and low grade glioma was 168.6 ml/100gm/min and 13.3 ml/100gm/min respectively with statistically significant difference between two groups (P=.023). Cut of value was 38.8ml/100gm/min for CBF with sensitivity 91% and specificity 100% and for men PS in low and high grade glioma was 0.25 and 13.9 respectively with statistically significant difference (P value =.005) , the cut of value was 2 ml/100gm/min with sensitivity 91% and specificity 100% , for mean MTT for high and low grade glioma 4.6and 7.08 respectively with no statistically significant difference (P value =0.137) .*

Conclusion: *CT perfusion is a valuable method in differentiation between low and high grade glioma, it has the advantage of wider availability, faster scan time and lower cost compared to MR perfusion.*

Keywords: *CT perfusion. Low grade glioma. High grade glioma.*

Introduction

Gliomas, the most common primary brain neoplasms in adults, are very heterogeneous tumors. High-grade gliomas can be highly invasive and extremely vascular tumors. Two of the most important factors in determining the malignancy of gliomas are their ability to infiltrate the brain parenchyma and to recruit or synthesize vascular networks for further growth (ie, neoangiogenesis). Malignant brain tumors are characterized by neovascularity and increased angiogenic activity, with a higher proportion of immature and highly permeable vessels.(1)

Perfusion imaging of brain tumors has shown that certain cerebral perfusion parameters such as regional blood volume and blood flow correlate well with tumor grade.(2)

Most of the prior perfusion studies comparing histologic features with perfusion parameters have used various MR perfusion techniques. However, recently perfusion CT (PCT) has been used as an alternative method in assessing cerebral hemodynamics for stroke and brain tumors. (2)

PCT allows measurement of tumor vascular physiology, and maps of tumor blood flow, blood volume, mean transit time (MTT), and permeability–surface area product can be generated. In view of the wider availability, faster scanning times, and low cost combined with its ease of quantification of various perfusion parameters as compared with MR perfusion, PCT is potentially well suited to studying brain tumors and monitoring tumor response to antiangiogenic agents.(2)

The aim of this study was to evaluate role of CT perfusion in differentiation between low grade and high grade glioma .

Patients and Methods

The study was conducted upon 32 patients. Each patient was subjected to: Complete history taking, clinical examination, conventional MR with contrast. Then CT perfusion study was performed using GE 4 multisclice CT. First non contrast enhanced CT study was done to localize the region of interest. For perfusion scan 50 ml non ionic contrast (Ultravist 300 , Schering ,Berlin ,Germany) was administered into an antecubital vein via 16- to 18-gauge needle by using a power injector at an injection rate of 4 ml/s. CT scanning was initiated 5 seconds after the start of the injection. At 5 seconds into the injection, a cine (continuous) scan is initiated with the following technique: 80 kV, 100–120 ma, and 1 second per rotation for a duration of 50 seconds.

CTP data were analyzed by using deconvolution – based commercial CT perfusion analysis software (CT PERFUSION; GE Medical Systems) to create maps of cerebral blood flow (CBF), cerebral blood volume (CBV), permeability surface area (PS) and mean transit time (MTT).

Calculation of cerebral blood flow (CBF) , cerebral blood volume (CBV) , mean transit time (MTT) and permeability surface area (PS) are done by placement of RIO upon the solid most enhanced portion of the tumor tissue, the area of necrosis or cystic degeneration are avoided. Comparison with the contra-lateral normal side was done by placement of RIO on the contra-lateral similar normal tissue.

The medical ethics were considered. The patients were aware of examination, patient's approval was taken.

Results

The study was done upon 32 patients with known or suspected brain glioma presented to the outpatient clinic of the neurosurgery department, Alexandria main university hospitals and referred to the radiodiagnosis department for medical imaging.

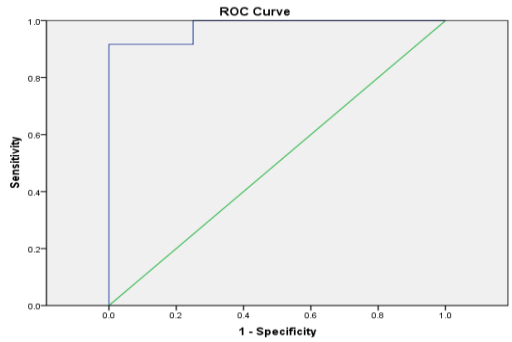
According to demographic data the age group was ranging from 20-80 years old, 25 cases were males and 7 cases were females.

24 cases were high grade glioma 20 cases were males and four cases were females while 8 cases were low grade glioma 5 were males and 3 were females

Table (1): Comparison between high grade glioma and low grade glioma regarding different studied variables.

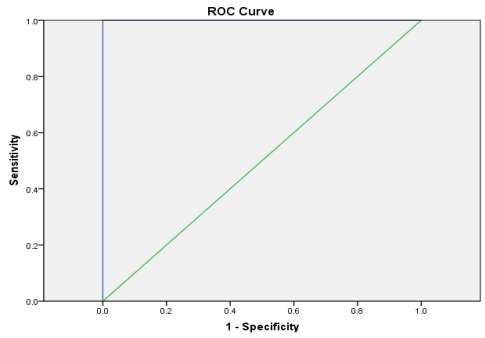
		N	Mean	S.D.	Min.	Max.	t	p
CBF lesion	High grade glioma	24	168.68	181.04	27.00	715.00	5.752	.023*
	Low grade glioma	8	13.31	15.01	.75	37.09		
CBV lesion	High grade glioma	24	11.50	20.17	2.60	76.70	2.272	.037*
	Low grade glioma	8	0.63	0.67	.11	1.70		
PS	High grade glioma	24	13.95	25.07	1.60	92.00	2.336	.005*
	Low grade glioma	8	0.25	0.22	.11	.60		
MTT	High grade glioma	24	4.69	1.34	2.30	6.90	4.073	.137
	Low grade glioma	8	7.08	5.47	3.50	15.90		

ROC curve of CBF level to detect the cut off value and the sensitivity and specificity.



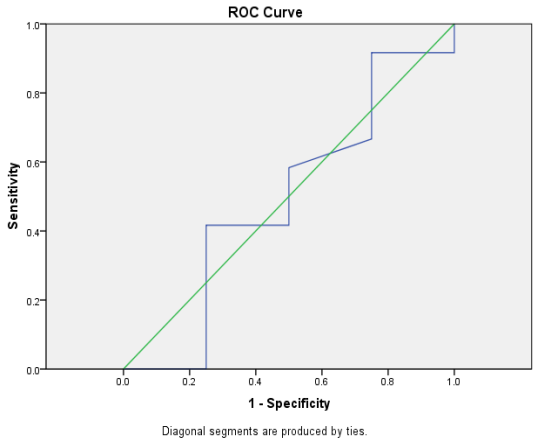
The cut of value regarding the CBF for differentiation between low and high grade glioma was 38.8ml/100 gm/min with sensitivity (91%) and specificity (100%) .

ROC curve of CBV level to detect the cut off value and the sensitivity and specificity



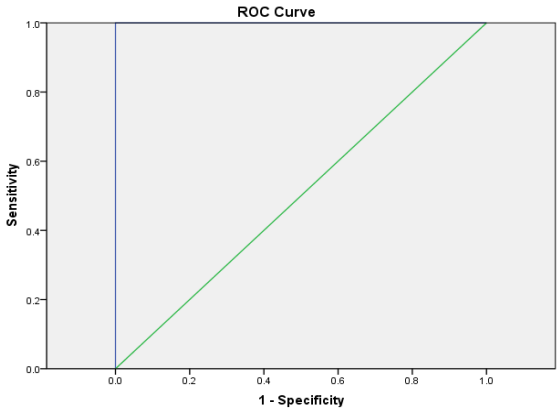
The cut of value regarding the CBV for differentiation between low and high grade glioma was 2.9 ml/100gm with sensitivity (91%) and specificity (100%).

ROC curve of MTT level to detect the cut off value and the sensitivity and specificity.



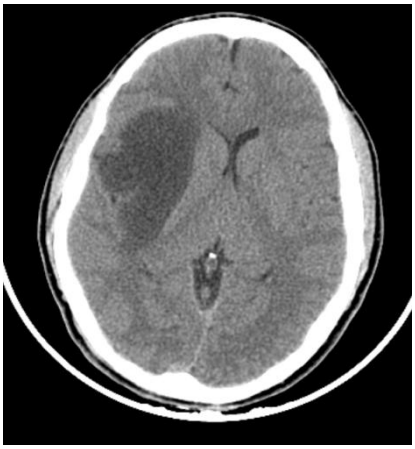
The cut of value regarding the MTT for differentiation between low and high grade glioma was 4.4 seconds with sensitivity (50%) and specificity (50%).

ROC curve of PS level to detect the cut off value and the sensitivity and specificity

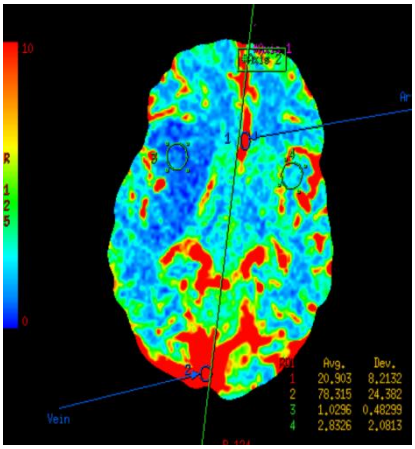


The cut of value regarding the PS for differentiation between low and high grade glioma was 2 with sensitivity (91%) and specificity (100%).4

Illustrative cases



a



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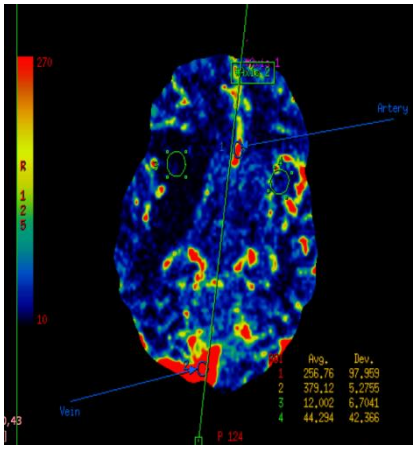
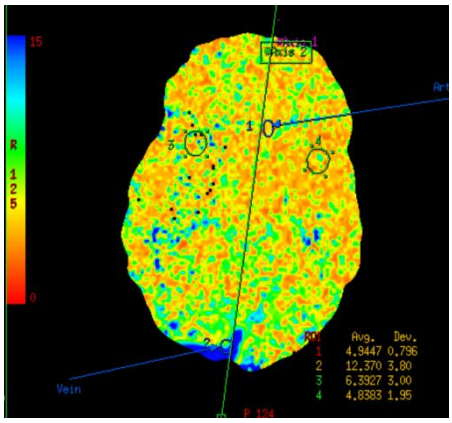


c



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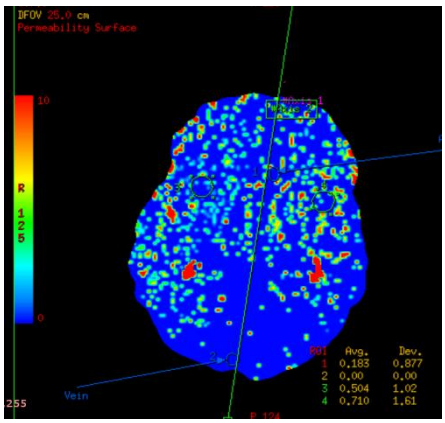
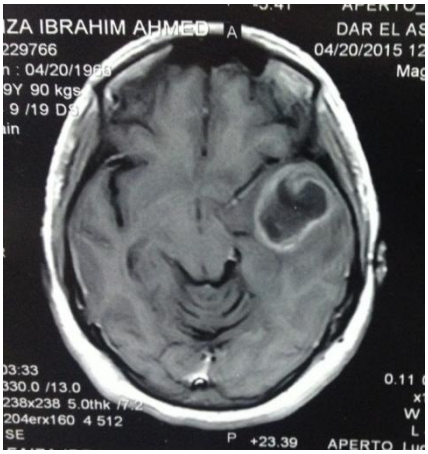
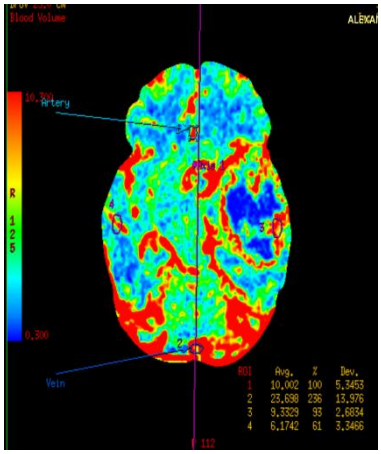


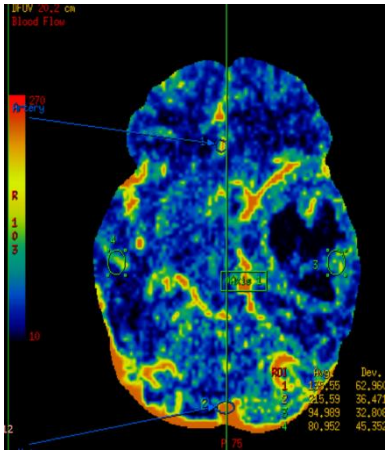
e

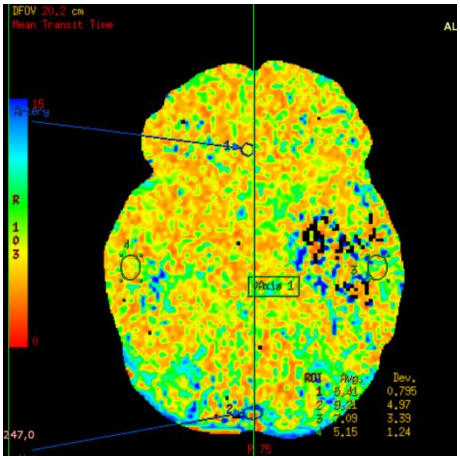
Case (1): 20 years old male patient presented with convulsion . (a) axial non contrast CT image shows large right temporal hypodense space occupying lesion exerting mass effect upon the ipsilateral lateral ventricle. (b,c) CBV and CBF color perfusion maps shows low BV and BF of the lesion (CBV 1 ml/100gm, CBF 12 ml/100gm/min), (d,e) MTT and PS maps shows mildly increased both MTT and PS of the lesion (6.3 sec, PS 0.5 ml/100gm/min)… collectively the finding are in favor of low grade glioma, *Histopathological examination conformed the diagnosis of grade I glioma.*

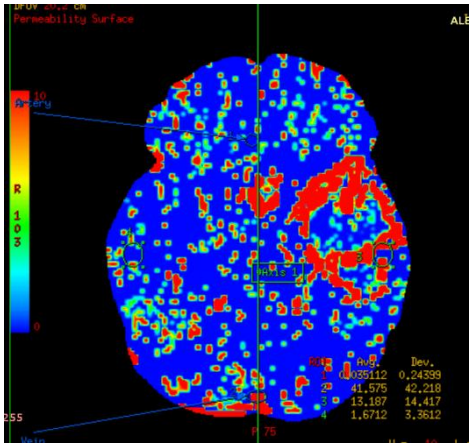
(a) (b) (c)











(d) (e)

Case (2) : 45years old female patient presented with right hemiparsis . (a) axial T1 post contrast MR image shows large left temporal space occupying lesion with marginal enhancement. (c,d) CBV and CBF color perfusion maps shows high BV and BF of the lesion (CBV 9.3ml/100gm, CBF 94.9ml/100gm/min), (d,e) MTT and PS maps shows increased MTT with evident increased PS of the lesion(MTT 7 sec, PS 13.1 ml/100gm/min)… collectively the finding are in favor of high grade glioma, *Histopathological examination conformed the diagnosis of grade IV glioma (glioblastoma multiform)*

Discussion

Perfusion imaging can provide information about flow dynamics of tumor vessels, particularly blood volume and permeability measurements that can be complementary to conventional imaging for preoperative grading of gliomas.[3]

In our study mean CBV for high grade glioma was 11.5ml/100gm and 0.36ml/100gm for low grade glioma with statistically significant value between two groups (P value= .037), the cut of value in our study was 2.9 ml /100gm (higher than 2.9 means this is high grade glioma) with sensitivity 91% and specificity 100%, regarding CBF for high grade and low grade glioma was 168.6 ml/100gm/min and 13.3 ml/100gm/min respectively with statistically significant difference between two groups (P=.023). Cut of value was 38.8 for CBF with sensitivity 91% and specificity 100% and for men PS in low and high grade glioma was 0.25 and 13.9 respectively with statistically significant difference (P value =.005) and cut of value was 2,for mean MTT for high and low grade glioma 4.6and 7.08 respectively with no statistically significant difference (P value =0.137) cut of point 4.4 sec with sensitivity 50% and specificity 50% were found to identify high grade glioma, these finding were consistent with Ahmed KA and Ellika SK results , yet our results showed higher values.

Ahmed KA et al [3] reported in a study included 40 patients with glioma highly significant difference ($P < 0.001$) between high and low grade glioma as regard the mean value of CBV in tumor sides where it is higher in the high-grade glioma group as the mean value of CBV in low-grade group = 1.46 ± 0.63 ml/100 g, while in high-grade group = 3.78 ± 1.66 ml/100 g.

Ahmed KA et al [3] found that there was highly significant difference ($P < 0.001$) between the low and high-grade glioma groups as regard the mean value of PS in tumor sides where it is higher in the high-grade glioma group as the mean value of PS in low-grade group = 1.95 ± 1.52 ml/100 g/min, while in high-grade group = 8.54 ± 4.5 ml/100 g/min. [3]

Ellika SK et al[4] reported in study included 19 patients with glioma mean nCBV in the high- and low-grade gliomas was 3.06 ± 1.35 and 1.44 ± 0.42, respectively, with a statistically significant difference between the 2 groups ($P = .005$). Mean nCBF for the high- and low-grade gliomas was 3.03 ± 2.16 and 1.16 ± 0.36, respectively, with a statistically significant difference between the 2 groups ($P = .045$). Cut points of >1.92 for nCBV (85.7% sensitivity and 100% specificity), >1.48 for nCBF (71.4% sensitivity and 100% specificity), and <1.94 for nMTT (92.9% sensitivity and 40% specificity) were found to identify the high-grade gliomas. nCBV was the single best parameter; however, using either nCBV of >1.92 or nCBF of >1.48 improved the sensitivity and specificity to 92.9% and 100%, respectively. [4]

Jain R et al [2] demonstrate that the differences in PS, CBV, and CBF between the low- and high-grade tumor groups were statistically significant, with the low-grade group showing lower mean values than the high-grade group. ROC analyses showed that both CBV (C-statistic 0.930) and PS (C-statistic 0.927) were very similar to each other in differentiating low- and high-grade gliomas and had higher predictability compared with CBF and MTT.

Conclusion

CT perfusion is a valuable method in differentiation between low and high grade glioma, it has the advantage of wider availability, faster scan time and lower cost compared to MR perfusion.

References

1. Jain R. Perfusion CT imaging of brain tumors: An overview. AJNR 2011; 32: 1570-7.
2. Jain R et al. Quantitative Estimation of Permeability Surface-Area Product in Astroglial Brain Tumors Using Perfusion CT and Correlation with Histopathologic Grade. AJNR 2008;29:694-700.
3. Ahmed KA, Abd Elhameed AM: Perfusion CT cerebral blood volume and permeability surface in low and high grades of brain glioma .The Egyptian Journal of Radiology and Nuclear medicine 2012;43(3):449-58.
4. Ellika SK et al. Role of Perfusion CT in Glioma Grading and Comparison with Conventional MR Imaging Features. AJNR 2007; 28: 1981-7.