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by Hartati Rusmi Tri Wilujeng

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Association of Diffusion Weighted Magnetic Resonance Imaging Profile and Apparent Diffusion Coefficient Value with Brain Tumor's Histopathology

Hartati Rusmi Tri Wilujeng[1], Anggraini Dwi Sensusiati[2], M. Yamin Sunaryo Suwandi[3]

[1]Radiology Department, [2]Department of Neurology, [3]Department of Thoracic, Dr. Soetomo Teaching Hospital, Faculty of Medicine, Universitas Airlangga, Surabaya 60285, Indonesia

Abstract

Background: Accuracy of preoperative brain tumor's histopathologic differentiation is very important to determine preoperative staging, intraoperative management and postoperative therapy. Diffusion weighted magnetic resonance imaging is an advanced technique developed as an important method for brain tumor assessment.

Objectives: This study aimed to investigate correlation between diffusion weighted imaging (DWI) profile and apparent diffusion coefficient (ADC) value with brain tumor's histopathology.

Methods: This study examined 86 subjects with brain tumors using magnetic resonance imaging and histopathology examination at Dr. Soetomo Teaching Hospital and evaluated DWI profile and ADC maps. The spherical ROI on ADC maps was placed on the solid part of the tumor to measure ADC value. Spearman's correlation test was conducted to determine correlation between DWI profile and ADC values with histopathological grading and types of brain tumor.

Results: There was a significant correlation between DWI profile and ADC values ($p = 0.000$), as well as DWI and ADC values with histopathological grading and types of brain tumor ($p = 0.000$). There was an inverse corelation between ADC value and histopathological grading. The higher the ADC value, the lower the brain tumor grade, while lower ADC value resulted in high tumor grade. The average ADC value of grade-1 meningiomas was $1.061 \pm 0.257 \times 10^{-3}$ mm^2/sec, pilocytic astrocytoma was $1.301 \pm 0.107 \times 10^{-3}$ mm^2/sec, glioblastoma multiforme was $0.831 \pm 0.080 \times 10^{-3}$ mm^2/sec, and medulloblastomas was $0.600 \pm 0.078 \times 10^{-3}$ mm^2/sec.

Conclusion: Evaluation on DWI profile and ADC value could provide additional information on conventional magnetic resonance imaging examination to determine histopathological grading and types of both intra and extra-axial brain tumors.

Keywords: *ADC value, brain tumor, brain tumor histopathology, DWI.*

Introduction

Accurate brain tumor diagnosis has an important role in selecting an optimal therapeutic strategy due to the the influence of tumor natural course and grading on therapeutic approach of preoperative, intraoperative and postoperative management. Conventional CT scan and MRI have limitations in differentiating intracranial lesions, with sensitivity, specificity, PPV and NPV of conventional MRI to determine high grade glioma. Therefore, many advanced MRI techniques are developed to improve the accuracy of preoperative brain tumor' histopathologic diagnosis [1].

Diffusion weighted imaging (DWI) is an advanced MRI technique that is currently being developed as an

Corresponding Author:
Anggraini Dwi Sensusiati
E-mail: anggrainidwifkunair@yahoo.com

important method for assessing brain tumor [2]. In general, malignant tumors have large cell nuclei and exhibit high cell density. A study has shown that malignant tumors have low ADC values than benign tumors [3]. Therefore, one of the most prominent contributions of DWI is the differentiation between malignant and benign brain tumors. The sensitivity, specificity, PPV and NPV and ADC values of DWI in differentiation of high-grade brain tumors and lymphomas with low-grade glioma and non-neoplasm cases were 94.1%, 78.2%, 76.1% and 94.7%, respectively.

Recently, there has been no data on DWI profile and ADC of brain tumor which is associated with histopathology examination result, especially in Dr, Soetomo General Hospital, Surabaya, Indonesia. These data are important to show whether there is a difference with previous research. They also can be used as a reference in determining the diagnosis and characterization of preoperative brain tumor using MRI examination. Therefore, we aimed to examined correlation of DWI profiles and ADC values with histopathological outcomes in both postoperative patients with intra-axial and extra-axial brain tumors.

Method

A retrospective study investigated correlation of DWI profile and ADC value with histopathology grading and type of brain tumor in post-brain tumor surgery patients at Dr. Soetomo Teaching Hospital, Surabaya, Indonesia. The subjects were patients with brain tumor who visited Neurosurgery Unit for head examination, surgery and histopathology examination.

All subjects should meet the following inclusion criteria: (1) Patients with intra-axial and extra-axial brain tumors; (2) Having a complete and accessible medical record; (3) Having performed head MRI with contrast and DWI sequence; (4) Having performed surgery and histopathological examination of tumor tissue. We excluded subjects with the following criteria: (1) There was no MRI file or have not performed any DWI sequence; (2) Intratumoral bleeding; (3) Intratumoral inflammatory process.

Subjects were taken using consecutive sampling technique. We used GE Optima 360 1.5 Tesla MRI machine. MRI examination protocol used head coil, while sequences made included T1WI using fast spin echo with Time repetition (TR) 250-750 ms and Time echo (TE) 10-20 ms (SE 250-750/10-20), T1WI + C, T2WI sequence (SE 4000-8000/100). DWI with b value of 1000 mm^2/sec was performed on axial pieces. ADC is a reconstruction of the DWI sequence. ADC value measurement in ROI tumors was round with size of 20-30 mm^2. It was placed in the denser area of the tumor that experienced signal intensity changes on DWI. ADC value measurement in normal brain parenchyma ROI had round shape of 20-30 mm^2, and it was placed in white matter on the counter-lateral side of the lesion. Gadolinium-DPTA (Omniscan, GE Healthcare Inc.) media contrast was administered intravenously to all patients with a dose of 0.1 mmol/kg WW.

Data processing and analysis begin with an evaluation of MRI examination results conducted by two neuroradiologists (ADS) and (WFA) who did not know of tumor tissue's histopathological examination results. Decisions were made by means of agreement if there were any difference in MRI interpretation.

Descriptive analysis was conducted to obtain the sample's characteristics. We conducted Kappa test to determine interobserver variation on the interpretation of MRI head examination. Spearman's correlation test was then performed to determine the correlation between DWI profile and ADC values with grading and histopathology type in brain tumor. The confidence limit used was 95% (95% CI) with significant p value <0.05. The statistical calculations used SPSS software (SPSS. Inc. Chicago. IL).

Results

We obtained 97 samples aged 1-82 years old, with average age of 33.39 years. Most subjects were found in the age group of 41-50 years (n = 24, 24.74%) followed by age group of 31-40 years (n = 23, 23.71%) and age group of less than 10 years (n = 21, 21.65 %). Table 1 showed subjects's distribution by Tumor Histopathology. Table 1 showed subjects' distribution by tumor histopathology.

Table 1. Subjects' Distribution by Tumor Histopathology

Histopathology	Frequency	Percentage (%)
Meningioma transitional	19	19.59
Pituitary adenoma	14	14.43
Medulloblastoma	9	9.28
GBM	6	6.19
Meningioma meningothelial	6	6.19
Pilocytic astrocytoma	6	6.19
Schwannoma	6	6.19
Meningioma atypical	4	4.12
Meningioma microcystic	4	4.12
Diffuse fibrillary astrocytoma	3	3.09
Anaplastic ependymoma	2	2.06
Meningioma fibroblastic	2	2.06
CNS PNET	2	2.06
Meningioma microcyst and angiomatous	2	2.06
Adamantinoma craniopharyngioma	1	1.03
Anaplastic astrocytoma	1	1.03
Anaplastic oligodendroglioma	1	1.03
Atheroma (dermoid cyst)	1	1.03
Choroid plexus carcinoma	1	1.03
Choroid plexus papilloma	1	1.03
Ependymoma clear cell	1	1.03
Germinoma	1	1.03
Mature teratoma	1	1.03
Meningioma microcyst and transitional	1	1.03
Psammomatous meningioma	1	1.03
Pilomyxoid astrocytoma	1	1.03
Total	97	100

ADC value characteristic of normal brain parenchyma by age showed that the age <17 years old have mean 0.865 (x10^{-3} mm^2/sec) with SD 0.045 and the age >17 years old have mean 0.820 (x10^{-3} mm^2/sec) with SD 0.057. ADC value of WHO grade I tumor was 1.152±0.042 x 10^{-3} mm^2/sec, WHO grade II was 1.063±0.081 x 10^{-3} mm^2/sec, WHO grade III was 0.865±0.080 x 10^{-3} mm^2/sec, WHO grade IV was 0.603±0.065 x 10^{-3} mm^2/sec. ADC value of facilitated and restricted diffusions in brain tumors were 1.139±0.037 x 10^{-3} mm^2/sec and 0.644±0.057 x 10^{-3} mm^2/sec, respectively. The average ADC value of facilitated and restricted diffusions in extra-axial brain tumor were 1.138±0.042 x 10^{-3} mm^2/sec and 0.642±0.083 x 10^{-3} mm^2/sec, respectively. The average ADC value of facilitated and restricted diffusions in intra-axial brain tumor were 1.140±0.075 x 10^{-3} mm^2/sec and 0.646±0.074 x 10^{-3} mm^2/sec, respectively.

Table 2. Brain tumor characteristics by DWI profiles and ADC value

Brain Location	Histopathology	WHO Grading	DWI Profile		ADC Value (x10-3 mm2/sec)	
			Restricted	Facilitated	Mean	SD
Intra -axial	Pilocytic astrocytoma	I		Facilitated	1.408	0.285
	Diffuse fibrillary astrocytoma	II		Facilitated	1.295	0.361
	Anaplastic astrocytoma	III		Facilitated	1.440	
	Anaplastic oligodendroglioma	III		Facilitated	0.970	
	Anaplastic ependymoma	III	Restricted		0.728	
	CNS PNET	IV	Restricted		0.430	
	Medulloblastoma	IV	Restricted		0.596	0.864
	GBM	IV		Facilitated	0.831	0.209
Extra-axial	Psammomatous meningioma	I		Facilitated	0.812	
	Meningioma microcystic	I		Facilitated	0.940	
	Meningioma microcystic and angiomatous	I		Facilitated	0.866	0.113
	Meningioma microcystic and transitional	I		Facilitated	0.938	
	Meningioma meningothelial	I		Facilitated	0.914	
	Meningioma transitional	I		Facilitated	0.979	0.129
	Meningioma fibroblastic	I		Facilitated	1.079	0.142
	Pituitary adenoma	I		Facilitated	1.045	0.304
	Schwannoma	I		Facilitated	1.047	0.106
	Adamantinoma craniopharyngioma	I		Facilitated	1.660	
	Choroid plexus papilloma	I		Facilitated	2.092	
	Pilocytic astrocytoma	I		Facilitated	1.194	
	Meningioma atypical	II		Facilitated	0.962	0.084
	Pilomyxoid astrocytoma	II		Facilitated	1.408	
	Anaplastic ependymoma	III	Restricted		0.710	
	Meningioma anaplastic	III	Restricted		0.658	
	Choroid plexus carcinoma	III	Restricted		0.685	
	CNS PNET	IV	Restricted		0.551	
	Medulloblastoma	IV	Restricted		0.605	0.033

Table 3 showed a significant correlation between DWI profile and ADC values (p = 0.000). The DWI profile showed a significant correlation with histopathology grading (p = 0.000), and ADC value significantly correlated with histopathology grading (p = 0.000).

Table 3. Correlation of DWI Profile and ADC Value with Brain Tumor's Histopathology Grading

Location	WHO Grading	DWI Profile	ADC Value (x $10^{-3}mm^2/sec$)	
			Mean	SD
Intra-axial	I	Facilitated	1.130	0,450
		Restricted	-	-
	II	Facilitated	1.185	0.109
		Restricted	-	-
	III	Facilitated	-	-
		Restricted	0.684	0.113
	IV	Facilitated	-	-
		Restricted	0.578	0.120
Extra-axial	I	Facilitated	1.408	0.087
		Restricted	-	-
	II	Facilitated	0.940	0.120
		Restricted	-	-
	III	Facilitated	1.205	0.138
		Restricted	0.728	0.195
	IV	Facilitated	-	-
		Restricted	0.619	0.470

Spearman's correlation between ADC value and brain tumor location (r = 0.119; p = 0.227)

Spearman's correlation between ADC value and DWI profile (r = .563; p = .000)

Spearman's correlation between WHO grading and DWI profile (r = .930; p = .000)

Spearman's correlation between ADC value and WHO grading (r = .514; p = .000)

Table 4 showed a significant correlation between ADC value and histopathology of brain tumors (p = 0.000).

Table 4. Correlation of ADC Value and Brain Tumor's Histopathology

WHO Grading	Histopathology	ADC Value (x 10-3 mm2/sec)	
		Mean	SD
I	Pilocytic astrocytoma	1.301	0.107
	Choroid plexus papilloma	2.092	0.195
	Adamantinoma craniopharyngioma	1.660	0.195
	Schwannoma	1.047	0.080
	Pituitary adenoma	1.045	0.056
	Meningioma fibroblastic	1.080	0.138
	Meningioma transitional	0.979	0.045
	Meningioma meningothelial	0.914	0.195
	Meningioma microcyst and transitional	0.938	0.195
	Meningioma microcyst and angiomatous	0.866	0.195
	Meningioma microcyst	0.940	0.138
	Psammomatous meningioma	0.812	0.195
II	Ependymoma clear cell	0.585	0.195
	Diffuse fibrillary astrocytoma	1.295	0.138
	Pilomyxoid astrocytoma	1.408	0.195
	Atypical meningioma	0.962	0.098
III	Anaplastic meningioma	0.658	0.195
	Anaplastic astrocytoma	1.440	0.195
	Anaplastic oligodendroglioma	0.970	0.195
	Anaplastic ependymoma	0.719	0.138
	Choroid plexus carcinoma	0.685	0.294
IV	Medulloblastoma	0.600	0.078
	GMB	0.831	0.080
	CNS PNET	0.491	0.138

Spearman's correlation between ADC value and brain tumor's histopathology (r = .563; p = .000)

Discussion

In this study, the average value of normal brain parenchyma's ADC white matter in age group less than 17 years was 0.865±0.045 x 10^{-3} mm^2/sec, while 0.820±0.057 x 10^{-3} mm^2/sec for age group more than 17 years. This value was higher than the normal value found in a study conducted by Thomas study (0.75±0.03 x 10^{-3} mm^2/sec) [4].

We found a significant correlation between DWI profile and ADC value (p = 0.000). The average ADC value in DWI profile of facilitated and restricted diffusions in brain tumor were 1.139±0.037 x 10^{-3} mm^2/sec and 0.644±0.057 x 10^{-3} mm^2/sec, respectively. In another study, ADC value less than 1.0-1.1 x 10^{-3} mm^2/sec indicated a restricted diffusion of water molecules [5]. Nevertheless, we found no significant correlation between ADC value and brain tumor location. The value of facilitated and restricted diffusions in intra-

axial and extra-axial brain tumors showed no significant difference.

MRI is a highly sensitive imaging modality for evaluating brain tumors, but conventional MRI has limitations to differentiate histopathologic types of most brain tumors. In this study, we found a significant relationship between ADC value and tumor histopathology grading (p = 0.000). This finding was consistent with a study that found higher ADC value led to LGG (WHO I, II), while lower ADC value led to HGG (WHO III, IV). These findings were consistent with a study that found low ADC value led to atypical or malignant meningiomas compared with benign [6].

Increased mitotic processes, necrosis, high cytoplasmic nucleus ratios and increased disturbed cell growth patterns are found in high-grade meningiomas, causing restricted diffusion of water molecules seen in DWI. On the other hand, benign meningiomas show little representation of a coherent histological organization, because they are composed of oval-shaped neoplastic or spindle cells that form threads, fascicles, cords, or nodules, which force water molecules to move relatively isotropic [1]. The location of pituitary adenoma could be affected by the air-induced susceptible artifacts in the sinuses and surrounding bones resulting in varying results on the evaluation of ADC values, but no data supporting this possibility has been obtained [7]. On the other hand, PCL as a hyperseluler tumor has been reported to have lower ADC values significantly greater than HGG and metastatic tumors[1]. A study reported that lymphoma and metastasis' ADC values were lower than glioma[8].

A study (n = 76) reported ADC tumor metastasis was 0.72×10^{-3} mm^2/sec (using b-value of 1,000 mm^2/sec) [9]. On the other hand, another study (n = 21) reported ADC tumor metastasis values ranging from 0.35 to 1.37 x 10^{-3} mm^2/sec, with an average of 0.79±0.23 x 10^{-3} mm^2/sec (using b-value of 1,000 mm^2/sec). Nevertheless, the study found no significant correlation between ADC tumor metastasis score and GBM [10].

A study reported that ADC_{min} value measured by multiple ROI was a significant preceptor for differentiating PCL with glioblastoma, with an optimal cutoff value of 0.72 x 10^{-3} mm^2/sec. The obtained average value of ADC glioblastoma and PCL were 0.79±0.20 x 10^{-3} mm^2/sec and 0.51±0.17 x 10^{-3} mm^2/sec, respectively [11]. However, there is limited analysis of ADC sample values with histopathology ependymoma and heterogeneous morphology and tumors, therefore the results of this group are not fully reliable and further research is needed [12].

Brain tumor is an abnormal growth of cells in the brain. Magnetic resonance imaging (MRI) is an advanced diagnostic tools that enable us to visualize anatomical details more clearly so superior in detecting abnormalities in the soft tissues of the brain [13]. Neoplasia refers to the growth of new cells that are different from the growth of cells around it [14]. Image segmentation has been popularly performed for researchers in the field of Biomedical, Informatics Engineering, and Statistical Computation [15].

Conclusion

ADC value measurement in both extra-axial and intra-axial brain tumors was a significant predictor of grading differentiation and histopathologic types of brain tumor. Clinicians could use this diagnostic method for comprehensive action planning and management of brain tumor cases.

Ethical Clearance: The study protocol was approved by the ethics committees of Dr. Soetomo Teaching Hospital, Surabaya, Indonesia.

Conflict of Interest : No conflict of interest reported from this research

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References

1. Patricia Svolos, Kousi E, Eftychia Kapsalaki. The role of diffusion and perfusion weighted imaging in the differential diagnosis of cerebral tumors : a review and future perspectives. Cancer Imaging. 2014;14–20.
2. Schaefer PW, PE G, RG G. Diffusion weighted MR imaging of the brain. Radiology. 2000;222:410–8.
3. Bozgeyik Z, Onur MR, Ahmed Kursad Poyraz. The role of diffusion weighted magnetic resonance imaging in oncologic setting Turkey. Quant Imaging Med Surg. 2013;3(5):269–78.
4. Thomas R. Diffusion Weighted Magnetic Resonance Imgaing Feature Of Intracranial Lesions. Banglore. 2011;
5. Haaga JR, Dogra VS, Forsting M. CT and MRI Of

The Whole Body. 5ed ed. Elsevier; 2009. 54–220 p.

6. Tantawy HI, Mohamad FF, Ismael AM. The role of advanced MRI techniques in differentiating typical, from atypical and malignant meningioma. Egypt Soc Radiol Nucl Med. 2010;4:411–9.
7. Suzuki C, Maeda M HK. Apparent diffusion coefficient of pituitary macrodenoma evaluated with line-scan diffusion-weighted imaging. J Neuroradiol. 2007;34:228–35.
8. Geoffrey S.Y. Advanced MRI of adult brain tumors. Neurol Clin. 2007;25:947–073.
9. Duygulu.G, Ovali.GY, Calli.AF. Intracerebral metastasis showing restricted diffusion: correlation with histopathologic finding. Eur J Radiol. 2010;74:117–20.
10. Kono K, Inoue Y, Nakayama K et al. The role of diffusion-weighted imaging in patient with brain tumor. Am J Neuroradiol. 2001;22:1081–8.
11. Sung JA, Hyun JS, C J-H, L S-K. Differentiation between primary cerebral lymphoma using the apparent diffusion coefficient : comparison of three different ROI methode. PLoS One. 2014;9(11):e112948.
12. Elzbieta J, P I, Sylwia C et al. Infratentorial tumors in children – value of ADC in prediction of grade of neoplasmas. Pol J Radiol. 2010;75(4):18–23.
13. Damayanti A, Werdiningsih I. Classification of magnetic resonance (MR) brain images using energy coefficient and neural network. Appl Math Sci. 2014;8(9–12):517–24.
14. Rizka N, Chamidah N. Lung Tumor Classification on Human Chest X-Ray Using Statistical Modelling Approach. In: IOP Conference Series: Materials Science and Engineering Annual Basic Science International Conference. Jawa Timur; 2019. p. 546–5.
15. Iriawan N, Pravitasari AA, Fithriasari K, Irhamah, Purnami SW, Ferriastuti W. Comparative study of Brain Tumor Segmentation using Different Segmentation Techniques in Handling Noise. In: International Conference on Computer Engineering, Network and Intelligent Multimedia. CENIM; 2018. p. 289–93.

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