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ORIGINAL ARTICLE

B Value Variation Using Adc Mapping Technique With Diffusion Weighted Imaging Sequence to Distinguish Musculoskeletal Tumor Malignancy

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ABSTRACT

Introduction: *Diffusion Weighted Imaging* (DWI) is a sequence which owned by MRI that used the diffusion of water molecules called Brownian motion. Accordingly, DWI is a noninvasive approach for investigating tumor histological content. The yield of ADC value influenced by b value parameter. The aim of this research is to oppose the diagnostic performance of DWI sequence by using b value of 800 s/mm² and 1000 s/mm² respectively at MRI 1,5 T for the indentification of clinically musculoskeletal tumors using ADC mapping as a quantitative marking tool. **Methods:** DWI has been done on 15 patients with soft tissue tumors and used two different b value of 800 s/mm² and 1000 s/mm² respectively. Then, it was placed ROI in a restricted area during post processing to produce ADC Mapping values. ROI measurement are taken to the solid section of the tumors. **Results:** ADC value when using b value of 800 s/mm² is higher than using b value of 1000 s/mm² ($p < 0,05$). The mean value of ADC on the use of b value of 800 s/mm² is $2.50\pm0,04x10^{-3}$ while on the use of b value of 1000 s/mm² is $1.96\pm0,03x10^{-3}$. Furthermore, b value in benign tumors group are higher than in malignant tumors group. **Conclusion:** ADC value was totally different when using different parameter of b value. And the best b value to distinguish malignant and benign musculoskeletal tumors is using b value of 800 s/mm².

Keywords: Diffusion Weighted Imaging, ADC Mapping, Musculoskeletal Tumors

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INTRODUCTION

Musculoskeletal tumors have two properties, which can be benign or malignant. Bone tumors are abnormalities in the neoplastic musculoskeletal system (1). It is required diagnostic tools to detect musculoskeletal tumors, to support the success of a diagnosis and prevent invasive procedures such as surgery and biopsy (14). Therefore, MRI plays a pivotal role in decisive the musculoskeletal tumors characteristics due to its excellent soft tissue contrast and its ability to create multiplanar reconstruction (2, 6). Diffusion Weighted Imaging (DWI) is one of the sequences owned by MRI that can be used as a non-invasive method to detect the histological properties of tumor, to distinguish between benign and malignant tumors characteristics (2, 6, 8). DWI has been widely applied to soft tissue tumor and has a high success rate (10, 11).

Diffusion is a used term to describe the movement of molecules in a network due to random thermal motion (4, 20). B value is the used parameter when DWI sequence is activated, on tumor soft tissue and it promising (6). B value is used parameter when DWI sequence is activated and describing how diffusion affects signal intensity in the following equation

$$b = \gamma 2G2\delta 2\ (\Delta - \delta/3)$$

where γ is the gyromagnetic ratio, G is the gradient strength, δ is the diffusion gradient duration and Δ is the time between diffusion gradient pulses. The b value depict the acquisition parameters and is expressed as seconds per square milimeter (12).

The unit value of a molecule that diffuses in tissue per second is called as ADC (*Apparent Diffusion Coefficient*) (20). ADC mapping technique is the calculation of ADC

value on each soft tissue voxel on post-processing time (20). It is a quantitative measurement to see tumor malignancy level. However, there are few factors that can influence ADC mapping value, including the use of b values. The choice of b value has a direct influence on the calculated ADC (3, 5). ADC values calculated from imaging studies performed using only relatively low b value would be significantly contamined by perfusion effect. Meanwhile ADC values calculated from higher b values are relatively free from perfusion effect (12, 13).

The purpose of this study is to differentiate between benign or malignant musculoskeletal tumor with non-invasive method known as DWI (*Diffusion Weighted Imaging*) parameter in MRI with ADC Mapping technique and to argue the diagnostic result of DWI parameter by using two different b value.

MATERIALS AND METHODS

The study was conducted at Dr Soetomo General Public Hospital, Radiology Unit between August to October 2018. A total 8 classification of musculoskeletal tumors from 15 patients (6 men and 9 woman, mean age 37,92±23,55) were examined. Ethics committee has been approved and informed consent were done. The patients data were kept confidential and only used for the research project.

All patients were studied using MRI GE Optima 1,5T. The standart imaging protocol consisted of the following sequences: T1WI axial, coronal and sagital with TR/TE (500-700/15-30), T2W axial, coronal, sagital with TR/TE (3000-4500/85-120), STIR axial, coronal, sagital with TR/TE (4000-5500/20-40), field of view was 20-35 and flip angle was 30^0.

The research was prospective by experimental approach. There were 15 patients were invited in this study. The inclusion criteria were: 1) patients with clinical musculoskeletal tumors both benign or malignant 2) male or female patients with 5-80 years old and they were willing to participate in this study 3) absence of pathology anatomy examination. And the exclusion criteria were: 1) patients with metalic prosthesis due led to safety hazard 2) pediatric patients with anesthesia 3) claustrophobic patients.

The subjects were examined by MRI using two different b value parameters, that were b values of 800 s/mm² and 1000 s/mm² respectively. The data generated from this study was quantitative of ADC Mapping using two different b value parameters. The subject results of MRI examination, then placed ROI in a restricted area during post processing to produce ADC Mapping values. When multiple tumor component (solid vs cystic, necrotic) are present, ROI measurement are taken to the solid section of the tumors.

The data processing in this study was quantitative. The ADC mapping data using two different b values was analyzed by IBM SPSS Statistic version 20 program used paired T test. In addition, to see the better results between b value use of 800 s/mm² and 1000 s/mm², it was seen from the highest mean rank score. The score result with the highest rank was the optimal b value in MRI musculoskeletal examination to determine malignancy level.

RESULTS

Table I indicates that when using b value of 800 s/mm², ADC value is higher than using b value of 1000 s/mm².

Table I : The Number and ADC Value of Benign and Malignant Masses on Two Different B Value

Age	Gender	Diagnosis	ADC mapping value	
			B value 800	B value 1000
12 yo	Male	Osteosarcoma	$1.25x10^{-3}$	$1.17x10^{-3}$
57 yo	Male	Malignant soft tissue sarcoma	$1.39x10^{-3}$	$1.28x10^{-3}$
13 yo	Male	Sarcoma ewing	$1.22x10^{-3}$	$1.11x10^{-3}$
22 yo	Female	Bone cyst tumor	$1.30x10^{-3}$	$1.20x10^{-3}$
77 yo	Female	*MBD distal humerus	$1.80x10^{-3}$	$1.70x10^{-3}$
60 yo	Male	Malignant soft tissue tumor	$0.93x10^{-3}$	$0.82x10^{-3}$
50 yo	Female	*MBD femur	$2.16x10^{-3}$	$1.92x10^{-3}$
32 yo	Female	Malignant soft tissue tumor	$1.93x10^{-3}$	$1.65x10^{-3}$
30 yo	Female	Osteochondroma	$2.24x10^{-3}$	$2.21x10^{-3}$
46 yo	Female	Malignant soft tissue tumor	$1.28x10^{-3}$	$1.25x10^{-3}$
77 yo	Male	Malignant soft tissue tumor	$1.65x10^{-3}$	$1.50x10^{-3}$
5 yo	Female	Osteosarcoma	$1.95x10^{-3}$	$1.84x10^{-3}$
21 yo	Female	Bone cyst tumor	$0.99x10^{-3}$	$0.90x10^{-3}$
29 yo	Female	Malignant soft tissue tumor	$9.59x10^{-3}$	$6.75x10^{-3}$
25 yo	Male	Schwanoma	$6.21x10^{-3}$	$4.28x10^{-3}$

*MBD = Metastase Bone Disease

The mean value of ADC on the use of b value of 800 s/mm² is 2.50 ± 0,04x10⁻³ while on the use of b value of 1000 s/mm² is 1.96±0,03x10⁻³ respectively.

There is a difference in ADC value generated by b value of 800 s/mm² and 1000 s/mm². The mean ADC value on b value of 800 s/mm² is 2.50 ± 0,04x10⁻³ while on b value of 1000 s/mm² is 1.96±0,03x10⁻³ respectively. ADC value when using b value of 800 s/mm² is higher than using b value of 1000 s/mm². Therefore, it can be concluded that using a small b value will produce a larger ADC value. However, using a b value of 800 s/mm² restricted areas is clearer compared to b values of 1000 s/mm².

In this study, ADC value of benign tumor group has a range of 2.24x10⁻³ - 6.21x10⁻³ on b value of 800 s/ mm², while b value of 1000 s / mm² has a range of values 2.21x10⁻³ - 4.28x10⁻³ respectively. Whereas, malignant tumor group has the values of 1.22x10⁻³ - 9.59x10⁻³ on b value of 800 s / mm² while the use of b value of 1000 s/ mm² has a range value of 1.11x10⁻³ - 6.75x10⁻³. Therefore, the mean value of ADC in benign tumor group on b value of 800 s/ mm² is 280.72± 4.22x10⁻³ while b value of 1000 s/ mm² is 146.37±3.24x10⁻³. Further, the malignant tumor group in b value of 800 s/ mm² is 238.04 ±2.12x10⁻³ while in b value of 1000 s/ mm² is 160.12±1.77x10⁻³ respectively.

DISCUSSION

MRI (*Magnetic Resonance Imaging*) has a pivotal role in the diagnosis of soft tissue masses due to its ability to showing soft tissue contrast. The diffusion technique involve the diffusion motion of water protons in the tissues and this result can provide information about the diseases. There is an important parameter while DWI (*Diffusion Weighted Imaging*) is activated known as B value. The selection of b value can affect diffusion gradient to weaken transverse magnetization, to capture MRI signal size or intensity (12, 16). B value parameter can affect diffusion signal intensity and sensitivity. Diffusion sensitivity is the ability to distinguish abnormal and normal diffusion in tissues (19). If the sensitivity gets stronger, the normal tissue will appear dark and the abnormal tissue will appear bright. In addition, the selection of b value can affect ADC value measurement since the perfusion effect appears when experiencing signal attenuation (18).

Our study demonstrate increased ADC (*Apparent Difussion Coefficient*) in benign tumor compared to malignant tumor, while the main ADC value in benign tumor on b value of 800 s/ mm² was 280.72± 4.22x10⁻³ while b value of 1000 s/ mm² was 146.37±3.24x10⁻³. Further, the malignant tumor group in b value of 800 s/ mm² is 238.04 ±2.12x10⁻³ while in b value of 1000 s/ mm² is 160.12±1.77x10⁻³ respectively.

The result in Table I indicates that there is a difference in ADC value generated by b value of 800 s/ mm² and 1000 s/ mm². The main ADC value on b value of 800 s/ mm² is 2.50±0,04x10⁻³ while b value of 1000 s/ mm² is 1.96 ±0,03x10⁻³ respectively. These study were comparable to Nagata et al (8) who stated that a larger or less restricted estracellular space, enable spin dephasing and loss of signal on diffusion weighted imaging. Moreover, an increase in ADC value indicates the movement of molecules in extracellular space and a loss of membrane integrity (2). This may be possible explanation for the increased diffusion of most benign soft tissue tumor. The same results that b value selection can affects the ADC measurement since the perfusion effect appears when attenuating the signal (18). However, this study demonstrate that there will be differences in generated ADC value when uses different b values. ADC value with b value of 800 s/mm² is higher than b value of 1000 s/ mm². Therefore, ADC value uses ADC mapping with a restricted network indicates an interconnected correlation (4,9). Furthermore, it can be concluded that using a smaller b value will produce a larger ADC value, therefore when using b value of 800 s/ mm², the restricted area seems clearer than using b values of 1000 s/ mm².

Statistical result uses paired T test indicates a significance value of 0.02 ($p < 0.05$). It can be concluded statistically there are significant differences when using b values of 800 s/ mm² and 1000 s/mm². In addition, selection of b value when using DWI sequence affects the resulting ADC value.

In this study due to the limitations of the sample number, we are not dividing into bone and soft tissue tumor groups. This study revealed that, referring to Table I there is a benign tumor group but has a large ADC value than those other benign soft tissue tumor. That is patient with schwanoma. It is found that b value of 800 s/ mm² has an ADC value of 6.21x10⁻³ s/ mm² while with b value of 1000 s/mm² has an ADC value of 4.28x10⁻³ s/ mm² compared to others benign soft tissue tumors that has an ADC value of 2.24x10⁻³ and 1.30x10⁻³ with b value of 800 s/ mm², while with b value of 1000 s/mm² has an ADC value of 2.21x10⁻³, and 1.20x10⁻³ respectively.

These results were comparable with Maeda et al (7) who stated that soft tissue tumors with myxoid has high ADC value compared to those that does not contain myxoid. It is because soft tissue tumors containing myxoid with higher number of myxoid matrix affects the increase in diffusion process. For instance, myxoid matrix is greatly seen in the interstitial spaces in many sof tissue tumors and this existence can affected the ADC values. Therefore, it can be concluded that ADC value with schwanoma contains more myxoid. However, in this study due

to the time limitations we did not compare with the histopathological results.

In the current study, ADC value with MBD which is a malignant tumor group has an ADC value of $1.80x10^{-3}$ with b value of 800 s/ mm^2, whereas with b value of 1000 s/ mm^2 has an ADC value of $1.70x10^{-3}$ respectively, when compared to other ADC values with schwanoma which is a benign tumor group that has a higher ADC value of $6.21x10^{-3}$ with b value of 800 s/ mm^2, whereas, with b value of 1000 s/ mm^2, ADC value is $4.28x10^{-3}$ respectively. This can be explained by the fact that the issues which affect ADC value increase are ROI placement and tumor shape. In this study, we have a shortage due to the researcher uses a manual ROI with elliptical or cylindrical characteristic on a computer workstation, therefore there are several normal areas which involved along with ROI placement. On patients with clinical schwanoma researcher uses two ROI to obtain ADC values since the lesions in patients with clinical schwanomas are more than one place. In addition (Fig 1.2) indicates there is normal tissue involved in the ROI area, therefore it can affects ADC values increase. These result were comparable to Maeda et al (7) who stated that because tumors with large necrotic areas contain liquid material, it resembles serous fluid and consequently affects the process of increasing diffusion. Therefore, it can affect ADC values measurement despite patients with clinical MBD belongs to malignant group with lower ADC values. Then, in this study due to the lesions in patients with clinical MBD are only in one place and tumor shape tends to be round when compared to clinical schwanoma.

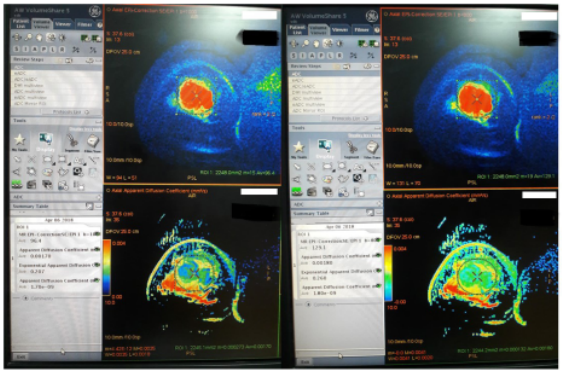

Fig. 1 : Axial image, T2W image, non contrast enhancement. ROI placement on the restricted area
Put down ROI in a restricted area during post processing to produce ADC Mapping values. When multiple tumor component (solid vs cystic, necrotic) are present, ROI measurement are taken to include the solid appearing portions of the tumors.

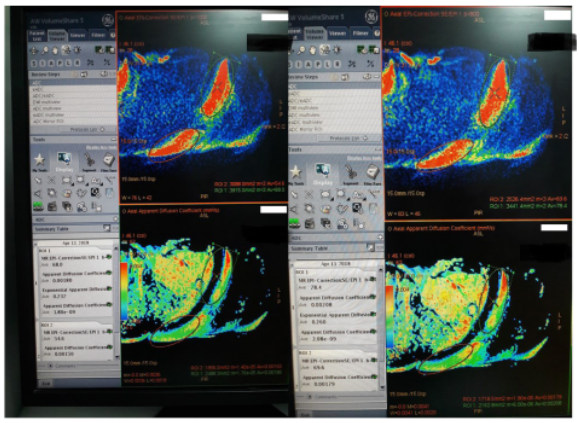

Fig. 2 : Schwanoma case in axial image with two different b value, T2W image, non contrast enhancement, using B value 800 s/mm^2 . ADC value was $4.28x10^{-3}$
ADC Mapping value on schwanoma case of the patient.

The others limitations of this study is that the heterogenous group of lesions has been studied, for instance metastasis and osteosarcoma on one hand, and bone cyst tumors on the others resulted in overlapped ADC results among malignant and benign bone tumors. Therefore, no definite conclusion can be drawn regarding a single disease entity. There were also none number and variety of histopathological types both of benign and malignant tumors due to brief surgical excision was done without further advanced MR imaging and the time limitations.

Statistical results indicate that optimal b value for differentiating the level of musculoskeletal tumor malignancy. The rank score of b value of 1000 s/mm^2 is 3.301 with a percentage of 40%. Therefore, it concludes that optimal b value for differentiating the level of musculoskeletal tumor malignancy is to use a b value of 800 s/ mm^2 with a percentage by 59%, whereas by using b value of 800 s/ mm^2 with a diffusion sensitivity of 59% can be claimed as higher than using b value of 1000 s/ mm^2 which only has a diffusion sensitivity of 40%. Therefore, by using b value of 800 s/ mm^2, the diffusion sensitivity can increase by 59% and it will affects the calculation of ADC value to increase the diagnostic value.

CONCLUSION

This study in investigating b value parameter for distinguish benign or malignant musculoskeletal are reported. From the results above, it can be concluded that there is a difference in image information between the use of b value of 800 s/ mm2 and b value of

1000 s/ mm2, moreover ADC Mapping value is also different. ADC Mapping in malignant tumor case is lower than in benign tumor case.

ADC values of soft tissue tumors are influenced by many factors, including tumor cellularity, tumor matrix and necrotic or cystic degeneration. Another factors influencing ADC is the fat component within the tumor and ROI placement.

This study indicate that the optimal b value parameter to differentiate level of musculoskeletal tumor malignancy is to use a b value of 800 s/ mm² which has been proven by using a paired T test statistic.

To sum up, diffusion measurements of soft tissue masses have potency as a non-invasive tool to differentiating of benign and malignant soft tissue lessions. It provide additional information, but further studies with a larger patient population and histopathological examination are required to validate the findings of this study.

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REFERENCES

1. Campbell. 2008. Operative Orthopaedics Eleventh Edition. Elsevier: USA.
2. Costa FM, Ferreira EC, Vianna EM. Diffusion-weighted resonance imaging for the evaluation of musculoskeletal tumors. Magn Reson Imaging Clin N Am. 2011;19(1):159-80.
3. Dietrich O, Heiland S, Sartor K. Noise correction for the exact determination of apparent diffusion coefficients at low SNR. Magn Reson Med 2001;45:448-53.
4. Filippi CG, Edgar MA, Ulug AM, et al. Appearance of meningiomas on diffusion weighted images: correlating diffusion constants with histopathologic findings. Am J Neuroradiol 2001;22:65-72.
5. Freiman M, Voss SD, Mulkern RV, et al. In vivo assessment of optimal b value range for perfusion insensitive apparent diffusion coefficient imaging. Med Phys 2012;39:4832-4839.
6. Khoo MM, Tyler PA, Saifuddin A, Padhani AR. Diffusion-weighted imaging (DWI) in musculoskeletal MRI: a critical review. Skeletal Radiol 2011;40:665-81.
7. Maeda M, Matsumine A, Kato H, et al. Soft-tissue tumors evaluated by line-scan diffusion-weighted imaging: influence of myxoid matrix on the apparent diffusion coefficient. J Magn Reson Imag 2007;25:1199-204.
8. Nagata S, Nishimura H, Uchida M, et al. Diffusion-weighted imaging of soft tissue tumors: usefulness of the apparent diffusion coefficient for differential diagnosis. Radiat Med 2008;26:287-95.
9. Niwa T, Aida N, Fujita K, et al. Diffusion weighted imaging of retriperitoneal malignant peripheral nerve sheath tumor in a patient with neurofibromatosis. Magn Reson Med Sci 2008;7:49-53
10. Pekcevik Yeliz, Kaya Ahmed. Characterization of soft tissue tumors by diffusion weighted imaging. Iran J Radiol. 2014;12(3)e15478.
11. Sherif AK, Mohamed AH, Naglaa MA, et al. Diagnostic impact of echo planar diffusion-weighted magnetic resonance imaging (DWI) in musculoskeletal neoplastic masses using apparent diffusion coefficient (ADC) mapping as a quantitative assessment tool. Egyptian Journal of Radiology 2012;43:219-226.
12. Sigmund, Eric. 2011. Ekstra Cranial applications of Diffusion-Weighted MRI. Cambridge University Press: New York.
13. Stejskal EO, Tanner JE. Spin diffusion measurements: spin echoes in the presence of a time-dependent field gradient. J Chem Phys 1965;42:288-92.
14. Subhawong Ty, Jacobs, Michael A, Fayad Laura M. Insights into quantitave diffusion weighted MRI for musculoskeletal tumor imaging. AJR. 2014;203:560-572.
15. Suzuki C, Maeda M, Matsumine A, et al. Apparent diffusion coefficient of subcutaneous epidermal cysts in the head and neck comparison with intracranial epidermoid cysts. Acad Radiol 2007;14:1020-8.
16. Taouli, Bachir. 2011. Ekstra Cranial applications of Diffusion-Weighted MRI. Cambridge University Press: New York.
17. Van Rijswijk CSP, Kunz P, Hogendoorn PCW, et al. Diffusion-weighted MRI in the characterization of soft tissue tumors. J Magn Reson Imag 2002;15:302
18. Yeung DK, Wong SY, Griffith JF, et al. Bone marrow diffusion in osteoporosis: evaluation with quantitative MR diffusion imaging. J Magn Reson Imaging 2004;19:222-8.
19. Westbrook, Catherine, dkk. 1999. MRI In Practice 2th Edition. Blackwell Publishing Ltd: UK.
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