CASE REPORT

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# Characterization of Classic Meningioma with Use of Conventional Magnetic Resonance and Diffusion Tensor Imaging

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ABSTRACT

**Introduction:** The conventional magnetic resonance imaging (MRI) method is widely considered 'with limited success' in differentiating the meningioma types but may fail to localize the tumor occupation of white-matter fiber bundles accurately. Diffusion tensor imaging (DTI) is considered as an imaging modality that may elucidate the microstructure of brain tumors. We provide characteristics of meningioma using DTI-based-three-dimensional tracing of white matter to portray meningioma in a noninvasive approach and its structural contact to contiguous tumors and elucidate the influence of occupying lesions on white-matter fiber bundles.

**Case Presentation:** A 28-year-old female presented with visuospatial disturbances and persistent headaches for 2 years. Conventional and advanced MRI studies were performed. Diffusion-weighted Images (DWI) and Apparent Diffusion Coefficient (ADC) values were measured in the lesion using routine MRI sequences. Advanced MRI using DTI was also performed. Conventional MRI outcomes showed tumor parenchyma, peritumoral edema, and compression on the circumnavigated brain tissue. There was hyperintense on DW trace image and isointense on ADC map. On T2-weighted image (T2WI) and Fluid-Attenuated Inversion Recovery (FLAIR) images, there was an increased signal intensity that demonstrated an extra-axial lesion, while T1-weighted imaging signals showed hypointensity. DTI fractional anisotropy (FA) marker is an unclear optic radiation in the concerned area, indicating the shift or destruction of the optic radiation. The mean FA values of solid-enhancing areas of meningioma were 0.28 ± 0.17. Mean ADC values (103 mm2/s) were 0.764 ± 0.172.

**Conclusions:** Classic meningioma in this case has low intratumoral FA and high ADC. DTI displayed that intratumoral microscopic water motion is disorganized.

## INTRODUCTION

Meningioma is considered the most prevalent primary intracranial tumor, and its prevalence rate reached up to 13–19% of all tumors in intracranial space affecting young adults [1]. The conventional magnetic resonance imaging (MRI) method by now utilized extensively 'with limited success' to differentiated the types of meningioma but may fail to localize the tumor occupation of white-matter fiber bundles accurately. Diffusion tensor imaging (DTI) imaging modality may elucidate the microstructure of brain tumors yet was rarely used in developing countries due to limited healthcare facilities [2,3]. We provide characteristics of meningioma using DTI-based-three-dimensional tracing of white matter to portray meningioma in a noninvasive approach and its structural contact to contiguous tumors and elucidate the influence of occupying lesions on white-matter fiber bundles. In addition, the use of DTI sequences serves to assess the cranial nerve pathways affected by the tumor mass. We report a single case of a patient with left parietal meningioma who has undergone surgery and confirmed through histopathological examination. The histopathological examination report diagnosed a typical meningioma which is considered a benign brain tumor based on histopathological classification. On the MRI, this patient showed a low intratumoral FA and high ADC, while the DTI displayed disorganized intratumoral microscopic water motion.

## CASE PRESENTATION

A 28-year-old female presented with visuospatial disturbances and persistent headaches for 2 years. Any previous surgical history is denied, her Glasgow Coma Scale (GSC) marked 15/15, with the absence of light perception. Urgent brain magnetic resonance imaging (MRI) was ordered. Conventional and advanced MRI studies were performed. Using routine MRI sequences, diffusion-weighted images (DWI) and apparent diffusion coefficient (ADC) values were measured in the lesion (**Figure 1**) and T1 weighted image (T1WI) contrast (**Figure 2**). Advanced MRI using DTI was also performed (**Figures 3 & 4**). The meningioma was located in the left parietal convexity.

Typical meningioma in this patient was located at the parietal lobe, showing hyperintensity parietal convexity mass on DWI, ADC shows as the slightly hypointense parietal convexity mass extending to the cortex, and on Fluid Attenuated Inversion Recovery (FLAIR) shows hyperintensity extending to the cortex. Axial T1-weighted image shows a well-marginated extra-axial mass in the parietal convexity, in contrast, an enhanced T1-weighted image shows hyperintensity and an axial fast-spin echo T2-weighted image shows hyperintensity mass expanding to the cortex. On 3D magnetic resonance, the tractography image and 3D optic radiotracer show compression to the left ventricle occipital horn and indicate smooth displacement in the left corticospinal tract.


**Figure 1.** (A) Parietal convexity mass is prominent as hyperintensity on the diffusion-weighted image; (B) On the ADC map, the mass be seen slightly hypointense to cortex; (C) Mass appears as hyperintensity extending to the cortex in fast fluid-attenuated inversion recovery.


**Figure 2.** Neuroimaging results in a patient diagnosed with classic meningioma. (A) Axial T1-weighted image of left parietal meningioma showing a well-marginated, extra-axial mass in the parietal convexity; (B) Contrast-enhanced T1-weighted image shows intense, homogeneous enhancement; (C) Axial fast spin-echo T2-weighted image portrays hyperintensity in the mass expanding to the cortex.


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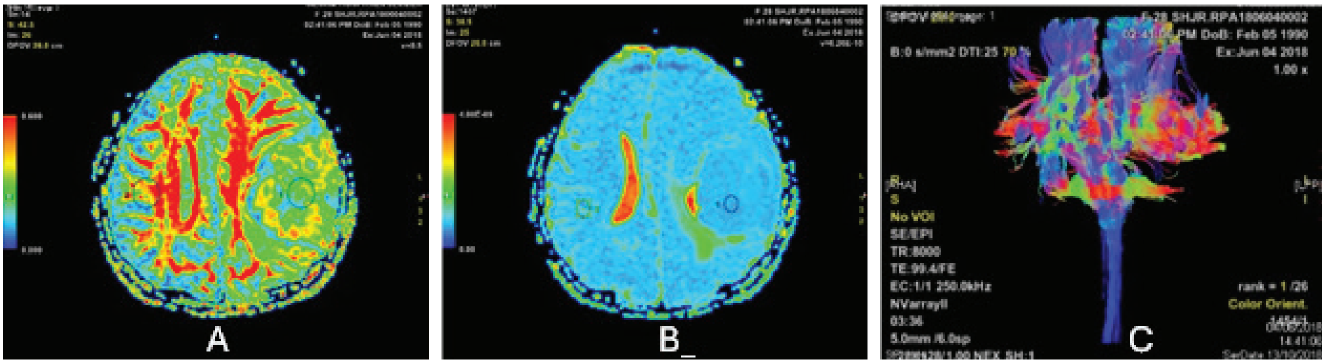


**Figure 3.** FA and ADC measurement (A, B) that Region of Interests (ROIs) are outlined in the enhancing tumor area and contralateral successively; (C) 3D magnetic resonance tractography images of parietal meningioma portrays smooth displacement and separation in contiguous white matter tracts.

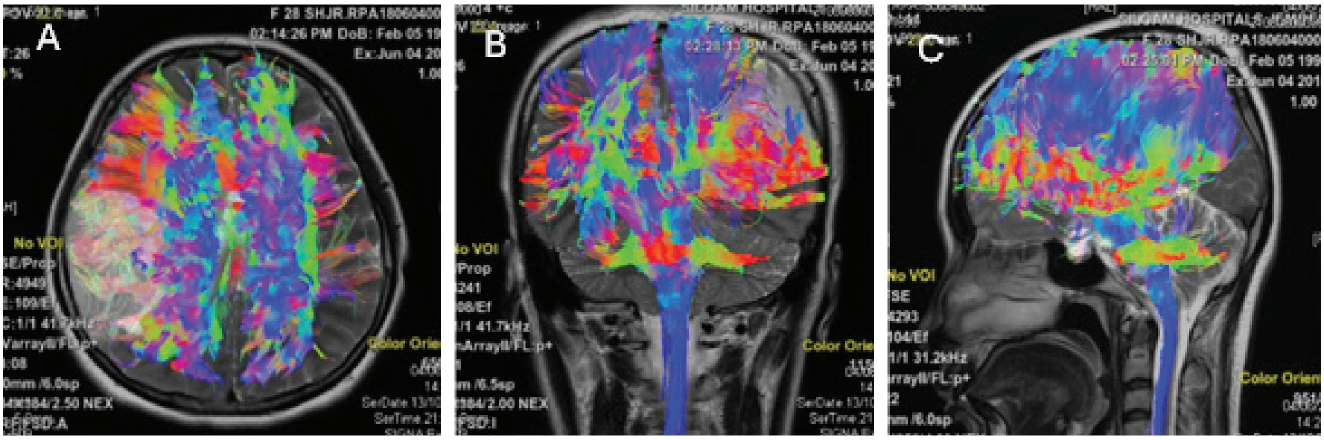


**Figure 4.** A three-dimensional optic radiotracer portraying the compression to the left lateral ventricle occipital horn indicates a smooth displacement in the contiguous left corticospinal tract. (A) Axial view; (B) Coronal view; (C) Sagittal view.

## DISCUSSION

Modality of MRI is a highly effective imaging technique for the diagnosis of meningiomas [4]. Conventional MRI exhibited tumor parenchyma, peritumoral edema, and compression to the circumnavigate brain tissue. There was hyperintense on DW trace image and isointense on ADC map. ADC values from the ADC map have been correlated with tumor cellularity. The rise in the ADC value can occur due to an increase in the amount of fluid in these lesions. The existence of more liquid facilitates the movement of water molecules and reduces the restriction on water diffusion. On T2 -T2-weighted imaging and FLAIR image, there was increased signal intensity that demonstrated an extra-axial lesion, while T1-weighted imaging signals were hipointens [5,6].

Fractional anisotropy is superior to mean diffusivity (MD) in the assessment and delineation of different degrees of glial tumor infiltration. In high-grade glioma, metastases had higher peritumoral FA and significantly lower MD due to the distinction with the surrounding tissues. The difference could have been that the significantly larger high-grade gliomas may have pushed and compacted surrounding white matter tracts. A larger tumor may increase the anisotropy of its surrounding tissue. Continuous decrease in FA of the tissue surrounding the tumor due to increased nerve degeneration or loss of neurons. The cutoff of FA in low-grade meningioma is 0.26 and 0.53 in high-grade meningioma [7,8].

Classic meningiomas compromise oval or spindle-shaped neoplastic cells which may shape nodules, cords, fascicles, or whorls. That nodules, cords, fascicles, or whorls existed in classic meningiomas shall act as physical barriers that can be viewed microscopically and avoid water molecules' linear movement [1,7]. As a result, the microscopic water motion of classic meningiomas fails a coherent organization along the tumor that may be inflicted at a greater proportion of spherical tensors. A substantial proportion of spherical tensors exhibit that microscopic water movement is more disorderly in classic meningiomas [8].

This is the first experience of the author to use DTI in mass evaluation pre-surgery. DTI fractional anisotropy (FA) gauges anisotropic water diffusion, provides evidence on the directionality of water diffusion, and portrays tissue integrality. FA provided unclear optic radiation in the predisposed area, pointing to the shift or destruction of the optic radiation. The mean FA values of solid-enhancing areas of meningioma were 0.28 ± 0.17. Mean ADC values (103 $mm^2/s$) were 0.764 ± 0.172 [2,8].

## CONCLUSIONS

Classic meningioma in this case has low intratumoral FA and high ADC. DTI disclosed that intratumoral microscopic water motion is disorganized. These findings are in concordance with low-grade meningioma as the previous research stated.

## DECLARATIONS

### Competing interest

The authors declare no competing interest in this study.

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