Histogram Analysis of Diffusion Metrics in Evaluation of Brain Tumors: Clinical Applications

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Target audience: Researchers and clinicians who investigate the brain tumors by using diffusion-weighted imaging and diffusion metrics.

Purpose: In clinical practice, conventional MR imaging is limited its ability to evaluate characteristics of brain tumors, such as classification. Recently, histogram analyses of diffusion metrics have showed promising results as imaging biomarkers[1, 2]. The purpose of this exhibit is to explain methods of histogram analyses of diffusion metrics and to demonstrate clinical usefulness of the analysis in evaluation of brain tumors.

Outline of contents:

1. We will explain the representative diffusion metrics used in histogram analysis for brain tumors, such as mean diffusivity, apparent diffusion coefficient (ADC), fractional anisotropy (FA) and mean diffusional kurtosis (MK)[3]. Moreover, we also explain analysis methods including double Gaussian mixed mode and single Gaussian model, and statistical parameters including median, skewness and kurtosis.

2. We will present examples that illustrate characteristic of brain tumors,

1) Classification of the grades and subtypes of brain tumors. For example, ADC histogram analysis can stratify patients with glioblastoma into high- and low- risk groups[2].

2) Demonstration of intratumoral microstructures. Different histogram patterns of diffusion metrics may be seen in the same brain tumor, depending on different component and ratio of the tumor cells and interstitial structures (Figure 1).

3) Determination of peritumoral invasion. In general, complex patterns are seen in the ADC and MK histograms in the area of peritumoral invasion because of the presence of both normal brain tissue and malignant tumor cells (Figure 2).

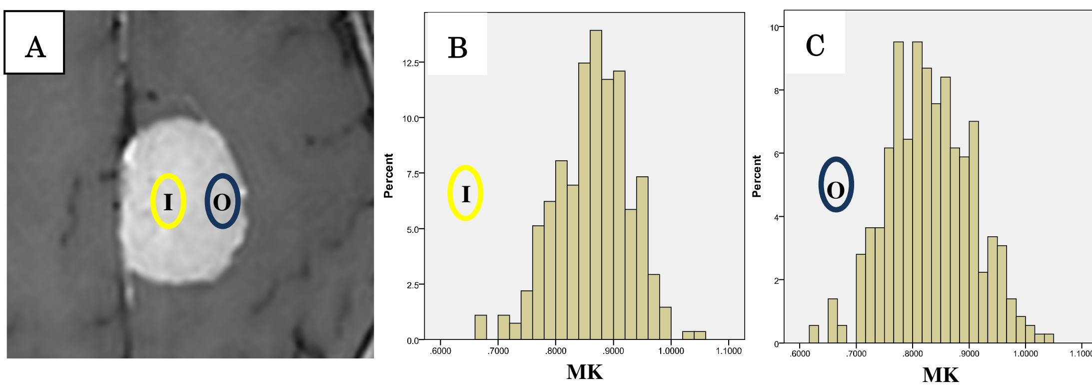

Figure 1. A contrast-enhanced T1-weighted image (A) shows a meningioma. Regions of interests are placed at the inner part (I, yellow circle) and the outer part (O, blue circle) of the tumor. Histograms of MK values at the inner part (B) and outer part(C). Intra-tumoral difference s of MK distributions is clearly demonstrated. Unit for MK is dimensionless.

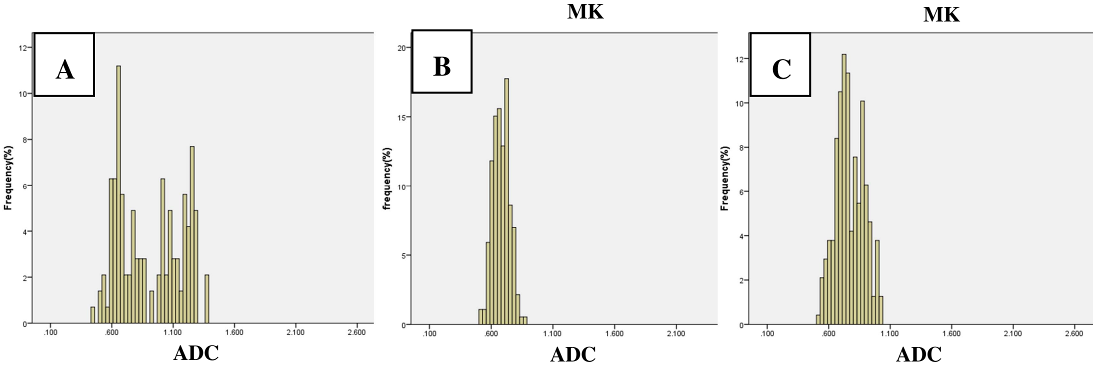

Figure 2. Histograms of peritumoral area of metastatic brain tumor (A), meningioma(B), and astrocytoma(C). Note that complex pattern was clearly seen in (A). Unit for ADC is μm^2/ms

Summary: This exhibit will demonstrate the various methods of histogram analysis of diffusion metrics and their usefulness to evaluate the characteristics of brain tumors. In case it is difficult for radiologists to reach comprehensive diagnosis with conventional imaging technique, complementary combination use of histogram analysis of diffusion metrics will be helpful for more precise diagnosis of brain tumors.

References: 1. Wang S, Kim S, Zhang Y,, et al. Determination of grade and subtype of meningiomas by using histogram analysis of diffusion-tensor imaging metrics. Radiology. 2012;262(2):584-92. **2**. Pope WB, Kim HJ, Huo J,, et al. Recurrent glioblastoma multiforme: ADC histogram analysis predicts response to bevacizumab treatment. Radiology. 2009;252(1):182-9. **3**. Jensen JH, Helpern JA, Ramani A, et al. Diffusional kurtosis imaging: the quantification of non-Gaussian water diffusion by means of magnetic resonance imaging. Magn Reson Med. 2005;53(6):1432–1440.