Glioma Screening and Classification Based on Magnetic Resonance

Rui Wang¹, Bo Wei², Le Wang³, Daliang Kong⁴, Guozhang Hu⁵, Chao Du²∗

ABSTRACT
In order to demonstrate the effect of perfusion magnetic resonance (MR) and diffusion tensor magnetic resonance imaging (MRI) in evaluating glioma, arterial spin labeling (ASL) imaging is used to calculate the hemodynamic parameter cerebral blood flow. Diffusion tensor imaging (DTI) is mainly used to analyze the diffusion coefficient of water molecules in the brain, obtaining anisotropic scores, average diffusion coefficients, diffusivity parameters, etc. The separability of these parameters is studied by analyzing the distribution of single parameters, single-model multi-parameters and multi-model multi-parameters. Parameters obtained in this paper are basically consistent with those reported in the previous literature, and the statistical analysis of each parameter is also basically the same as that of predecessors.

Key Words: Arterial Spin Labeling (ASL), Diffusion Tensor Imaging (DTI), Glioma

Introduction
Glioma is a kind of common internal tumor with high degree of malignancy and high fatality rate. It usually takes few weeks or months to find (Basser et al., 1994). According to the malignancy of the tumor pathological tissue, the glioma is divided into four levels (Goga et al., 2014). The low-grade glioma is benign, and the survival time after the operation is generally more than five years, while the high-grade glioma has a high degree of malignancy, and the survival time is short, usually about one year (Castillo et al., 2001). Therefore, the diagnosis and treatment of glioma are widely concerned in clinical practice (Warmuth et al., 2003). At present, the diagnosis and classification of glioma is through needle biopsy to determine. Before the biopsy, anatomical structure imaging is needed to view the tumor location, and then extract biopsy tissues under guidance (Manjon et al., 2008). Main problems of biopsy are that firstly, extracted tumor tissues cannot accurately reflect the situation of tumor. Because the biopsy selection is affected by doctors’ subjective factors to a large extent. The extracted tumor tissues may be not from the most serious part, leading to inaccurately pathological judging, which will affect the subsequent treatment plans, radiation doses, patient’s life quality and survival time ultimately (Wang et al., 2003). Secondly, biopsy is a kind of invasive method, which needs to be completed during the operation (Petersen et al., 2006). It is clinically concluded that only after the classification of glioma is determined the design of a targeted treatment plan.

Using non-invasive means (for example, imaging) to quantify the glioma evaluation is an important clinical problem, and of great
significance for the condition evaluation, operation program establishment and curative effect evaluation (Inoue et al., 2005). At the same time, malignant tumors seriously threaten human life. Correctly evaluating its physiological functions and states is of great scientific significance to understand behaviors and guide scientific researches on tumors. MRI is an important non-invasive medical imaging technique. Routine MRI can provide the tumor boundary, space occupying effect, degree of necrosis and other relevant pathological signs. But this information can only provide the anatomic structure and the approximate location of lesion, lacking of specificity in grading glioma and identifying benign or malignant. Therefore, there are obvious limitations in the diagnosis and classification of glioma. With the development of MR technology, especially the development of contrast agent technology, researchers have shifted from simple anatomical structure research to functional research.

Routine MRI is a qualitative research on pathological conditions. After the quantitative MRI is put forward, a variety of functional quantitative MRI researches appear. These imaging data are collected and modeled, obtaining various parameters, which reflect human physiological conditions. For example, perfusion MRI can detect hemodynamic information, and obtain the blood flow, blood volume, vascular permeability and other parameters. These parameters can reflect tumor angiogenesis, vascular permeability and blood flow information, which are closely related to the diagnosis and classification of glioma.

Diffusion tensor MRI mainly studies the diffusivity of water molecules in the body's tissues. The average diffusion coefficient, anisotropic diffusion scores and other parameters are achieved by measuring the diffusivity of water molecules to assess tissues' functions. Under the pathologic state, tissues with low diffusivity may be affected by the tumor to increase diffusivity. The internal diffusion coefficient in tissues is measured to assess the malignant degree of tumor.

Methods
Analysis is a common method for calculating parameters in glioma classification study. All studies on quantitative research of glioma classification have adopted analytical methods whatever the imaging modality. At present, the most common analytical method is to choose a small part of the tumor parenchyma as the interested area, which is called small ROI analysis method or local ROI analysis method, as shown in Figure 1. Figure 2 shows the ROI analysis method for edema area, which selects the ROI analysis method around the tumor parenchyma as the interested area. The ROI analysis method of tumor area in abnormality is shown in Figure 3 that selects the non-specific area and covers the entire imaging layer within the tumor area. Figures 1, 2 and 3 are schematic diagrams of three ROI analysis methods.
preferred method for doctors. For instance, in the study of the role of imaging in glioma classification, a pixel point is selected in the tumor parenchyma. This method is of high dependence of analysts. Researchers have different choices in selecting the area in the tumor parenchyma, and even the same researcher also has different choices in different time, thus results will be significantly various, ultimately affecting the results of study. Different researchers get different conclusions. Only when the analyst is an experienced oncologist and chooses the most representative area of the tumor can get stable results. Therefore, the small ROI analysis method is influenced by subjective factors, with poor repeatability and low stability. In this case, repeatability refers to whether different researchers have the same result, or the same researcher obtains the same results at different time. Thus, the small ROI analysis method only selects a small part of the tumor, which cannot fully represent the whole. This method has a poor reproducibility with an array of human factors, which is not easy to obtain reliable results.

The second method is specific to the edema area, which is formed mainly due to glioma infiltration in the brain parenchyma. This is another way to study the effect of glioma on brain tissues, which can assist the analysis of tumor pathology. This method is not widely used, and the general analysis is from the internal selection of the tumor.

The third method will include images of the tumor location, while other images that are too low or too high may not be involved in the analysis. Although results of this method are referential, the pertinence of this analysis is poor. All images that contain tumor areas need to be included in the calculation, and such images may have a dozen layers. Due to the large number of medical images, the pixel of this method is too large, and the analysis time is too long. Non-tumor tissues also are involved in the analysis, which influences the analysis results.

**Results and discussion**

With the big ROI, this study have improved the ROI analysis and put forward a new tumor ROI extraction method on multimodal MR, to reduce the dependence on researchers, obtain stable and reliable ROI, and calculate various parameters, such as ALS and DTI. The repeatable ROI extraction method does not need special experience, as long as you can see the image layer and the surrounding area have different tumor areas. This part of abnormal area can be called ROI. The repeatable ROI extraction flow chart is shown in Figure 4.

![Repeatable multimodal extraction flow chart](image)

Secondly, the tumor area is delineated in the image, and then the image is further analyzed, as shown in Figures 5 and 6.

![ASL images obtained after imaging](image)

![DTI FA image after imaging](image)

From extracted areas of Figures 5 and 6, it can be seen that if inexperienced researchers also can recognize the location of abnormal areas according to these three images, abnormal areas can be circled in the image with red rectangles as shown in the figure. The actual chosen area does not necessarily need to be a rectangle, which is
convenient to illustrate. The choosing method is simple, and there is not much difference in areas chose by the same researcher at different time or different researchers.

Furthermore, the separability of these parameters is studied by analyzing the distribution of single parameters, single-model multi-parameters and multi-model multi-parameters. A quantitative analysis on the separability criterion of each parameter for glioma classification provides two kinds of imaging modalities that can distinguish high-grade and low-grade glioma. Through the separability criterion, the most separable parameter combination is found. This paper deals with the selection, and the combination of specificity and sensitivity parameters of glioma classification. Statistical analysis is performed to select five significantly different parameters. It is proved that the result of this method is consistent with that of previous reports and can replace the previous one.

**Conclusion and prospect**

This paper mainly studies the application of two kinds of MRI methods in the classification of brain glioma. The main research results and innovations of this paper include the following three parts.

Firstly, this study integrates relevant algorithms of current image processing, and realizes the batch processing of the blood flow calculation of glioma. A perfusion-weighted image is achieved through correcting, pretreating, scalping and filtering, representing the blood flow chart of brain glioma physiological information.

Secondly, the new de-noising method based on filtering is proposed to improve the accuracy of the calculation under the condition of reducing the number of data collection. Compared with the conventional gaussian filtering method, the accuracy is improved, which is beneficial to the further analysis. The changes of various parameters may affect the performance of algorithms, which has been discussed. This influence is quantitatively analyzed with parameters, so as to obtain the optimal parameter combination of filtering under the current image resolution ratio.

Thirdly, this paper finds a repeatable and multimodal extraction method to provide reliable input parameters for quantitative analysis of glioma and solve the problem of dependence. Parameters obtained in this paper are basically consistent with those reported in the pervious literature, and the statistical analysis of each parameter is also basically the same as that of predecessors.

**References**


