The purpose of this study is to determine whether the signal characteristics of meningiomas on perfusion-weighted images correlate with the relative cerebral blood volume (rCBV) and histopathologic findings and whether they can distinguish benign and malignant meningiomas with rCBV ratios. Multifocal spin-echo EPI sequence was used to calculate rCBV maps from 13 patients with 14 tumors. Surgery and pathology were also performed to compare with rCBV results. Our study indicated that the average rCBV of meningioma is significantly higher than the normal brain tissue and correlated well with vascularization which is one of the criteria for histologic analysis.

**Materials and Methods**

13 patients (5 females and 8 males; average age, 37.6 years) with 14 meningiomas were prospectively studied using MR imaging and perfusion-weighted imaging. All the MR imaging was implemented on 1.5T MR scanner (Signa Nvi, GE Medical System, Milwaukee, WI) with a standard head coil. The conventional imaging protocol consists of T1SE, T2FSE and fast-FLAIR sequence pre and post contrast administration. SE-EPI MR images were acquired as axial sections, which were selected from unenhanced images. The parameters are as follows: thickness 8 mm, Gap 6, TR/TE = 1900/80 ms, FOV 30, Matrix 192 X 128, NEX 1.

Before the recording of perfusion-sensitive MR imaging took place, a 9-gauge intravenous needle was inserted in the vein of the right or left antecubital fossa. A 0.2 mmol/kg of gadolinium was injected with a mechanical injection pump (3 mL/s), followed by a 15-mL saline flush. A series of images was obtained using a lipid-suppressed EPI technique before, during, and after the injection of contrast agent. For all patients, 40 images were obtained at each slice during a 77 second period.

The start and end points of the first-pass transit of the contrast agent through the brain were identified using the time-activity curve of the means of the signal magnitude. Before the starting point of the first-pass circulation (seen as a drop in the signal), a representative number of baseline points were selected and their average was calculated as a baseline measure for signal intensity \(S_0\). The rCBV was calculated by the following equation:

\[
AR2^* = \frac{-ln (S/S_0)}{TTE}
\]

The rCBV ratio was calculated by reference to an internal contralateral standard.

The grade of vascularization was divided into 3 grades which was calculated by microscopy investigations: Grade I, less than 10 vessels in 20x visual field; Grade II, 10-15 vessels in 20x visual field; and Grade III, up 15 vessels in 20x visual field. The type of meningioma was classified by the World Health Organization (WHO) standard. The relationship of the tumor grade and to the mean rCBV ratios and the relationship of the grade of vascularization to the mean rCBV ratios were analyzed using Student's t test.

**Results and Discussions**

2 meningiomas were malignant (WHO II or III) and 12 cases were benign meningiomas (WHO I). The rCBV of tumor is from 7.2 \pm 5.5 to 206.4 \pm 73.4. The result was showed on Figure 1. The mean rCBV ratios between Grade I and Grade II to III were 8.84 and 3.23, respectively, which has significant difference. But the mean rCBV ratios do not have a significant difference between benign and malignant meningiomas.

Figure 2 showed a patient with two different histological type meningiomas, the left one is transitional meningioma and the right one is fibroblastic meningioma. The imaging feature has no difference between them. However, the vascularization of the two tumors belonged to Grade II and I, respectively. Their mean rCBV ratios have a significant difference which can be seen from the rCBV map.

**Conclusions**

The pathological difference between benign and malignant tumors included cellularity, vascularization, nuclear abnormality, etc. It was difficult to distinguish by depending only on one characterization. Although mean rCBV ratios can provide the information about increased vascularization, tumor grade still can not be determined. The findings suggest that the SE-EPI technique has limitations on distinguishing the grade of meningiomas.

**References**