

CASE REPORT

Multi-parametric MRI Diagnoses Cerebellar Hemangioblastoma: A Case Report

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Abstract We performed contrast-enhanced T2 fluid-attenuated inversion recovery (T2-FLAIR) and dynamic contrast enhanced MRI to illustrate the imaging characteristics of one case of hemangioblastoma. T2-FLAIR showed a large cyst located in the right cerebellum with mural nodule. The intensely enhancing cyst wall was observed on enhanced T2-FLAIR images acquired from 5.6 to 23 minutes after contrast administration, and quantitative dynamic contrast enhanced-MRI demonstrated that both the cyst wall and mural nodule presented high Ktrans, Kep and Ve values compared with the contralateral normal cerebellar tissues. The cyst showed gradual enhancement and reached the highest signal intensity at 67 minutes after contrast administration on enhanced T2-FLAIR images. In conclusion, early enhancement of cyst wall on T2-FLAIR might be the characteristic imaging findings for cystic hemangioblastoma, which may assist in the diagnosis of hemangioblastoma preoperatively.

HEMANGIOBLASTOMA is a benign brain tumor with rich blood, and 1.5%-2.5% of HGBLs occur in the brain, 7%-12% in the posterior cranial fossa, and 76% in the cerebellum.¹⁻² The typical imaging findings of hemangioblastoma are cysts with mural nodules. However, the imaging findings of hemangioblastoma are diverse,

making its diagnosis difficult. In the previous study,³ we reported a hemangioblastoma case diagnosed by enhanced T2 fluid-attenuated inversion recovery imaging (T2-FLAIR). In the current study, enhanced T2-FLAIR and dynamic contrast enhanced MRI were used to find the imaging characteristics of hemangioblastoma.

CASE DESCRIPTION

A 47-year-old female patient had complained of headache, nausea, and gait instability for 20 days and suffered from severe vomiting for three days. She was admitted to the Hainan Branch of Chinese PLA General Hospital in July, 2018 and a CT scan was performed.

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CT imaging showed a mass in the right cerebellum. She had not received any therapy before.

The patients underwent brain MRI after hospitalization. MRI was performed on a 3.0T MRI system (GE Healthcare, Milwaukee, WI, USA) equipped with an eight-channel head coil. The parameters for plain and contrast enhanced T2-FLAIR sequence were as follows: repetition time (TR) 8004 ms, echo time (TE) 148 ms, inversion time (TI) 2000 ms, field of view (FOV) 24 cm×24 cm, matrix 512×512, and slice thickness 3 mm.

The parameters for dynamic contrast enhanced (DCE) imaging were as follows: (1) Five consecutive axial three-dimensional T1-weighted fast spoiled gradient recalled echo (3D T1-FSPGR) sequences were performed with an array of flip angle (3° , 6° , 9° , 12° and 15°). (2) DCE MR sequence was performed with 3D T1-FSPGR (flip angle, 12°) with 20 phases. 3D FSPGR parameters were as follows: TR 6.9 ms, TE 3.2 ms, FOV 20 cm×20 cm, matrix 288×288, and number of acquisition (NEX) 1. Gadodiamide (0.1 mmol/kg, Omniscan, GE Healthcare) was given intravenously at a rate of 2 ml/s using a power injector (Spectris; MedRad, Warrendale, PA, USA). Each contrast bolus injection was followed by 20 ml of normal saline flush injected at 2 ml/s. (3) The scanning planning was arranged as follows: 1) plain MRI scanning including axial T2WI, T1WI and T2-FLAIR; 2) five 3D T1-FSPGR sequences with an array of five different flip angles (3° , 6° , 9° , 12° and 15°); 3) DCE-MRI sequence (flip angle 12°) with contrast administration; 4) enhanced T2-FLAIR at 5.6, 17, 23 and 67 minutes after contrast administration subsequently.

MR data were processed using an Omni-Kinetics workstation (GE Healthcare, LifeScience, China). The processing steps included: (1) Multiple flip angle 3D

T1-FSPGR images were used to perform T1 mapping to acquire T1 value of the brain tissue. (2) Contrast agent concentration in the tissue was calculated using tissue signal intensity. (3) Population-based arterial input function (AIF)⁴ and two-compartment extended-Tofts linear model⁵ were used to calculate pharmacokinetic parameters mapping, which included as follows: Ktrans mapping, quantification of volume transfer constant from plasma to extravascular extracellular space (EES); Kep, efflux rate constant from EES back to plasma; Ve, ratio of EES volume to tissue volume; Vp, ratio of blood plasma volume to tissue volume. (4) Region of interests (ROIs) (area, 60-80 mm²) were placed on enhanced T1 images (Fig. 1), and then the working ROIs were automatically placed on the corresponding Ktrans map. Finally, Ktrans parameters were reported for the further analysis.

Conventional MRI findings demonstrated that the lesion located in the right cerebellum, which consisted of a large cyst and solid mural nodule. The mural nodule presented evident enhancement, and the cyst and cyst wall did not present enhancement on the post-contrast T1WI (Fig. 2).

Plain T2-FLAIR identified that the mural nodule presented slight hyperintensity, and the cyst presented slight hypointensity (Fig. 3A). Enhanced T2-FLAIR demonstrated the nodule with no obvious enhancement (Fig. 3B-E). However, the cyst did present gradual enhancement from 5.6 to 67 minutes after contrast administration (Fig. 3B-E, G). Fig. 3E demonstrated the cyst with obviously enhanced intensity compared with the normal cerebellar parenchymal tissue at 67 minutes after contrast administration.

Figure 4 demonstrated an intense enhancing cyst that was observed from 5.6 to 23 minutes after con-

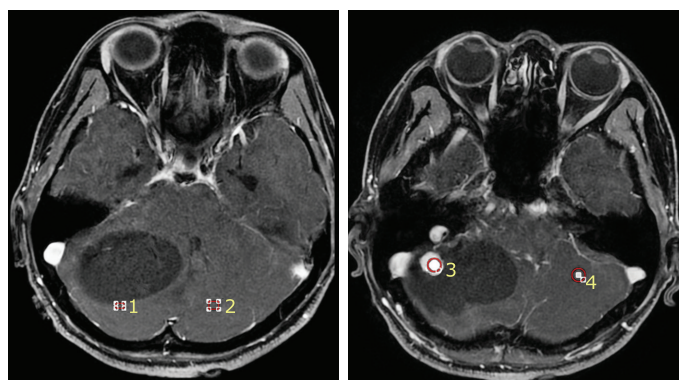


Figure 1. Region of interest (ROI) was placed on the enhanced T1 weighted images. ROI-1: tumoral cyst wall; ROI-2: contralateral normal cerebellar parenchymal tissue; ROI-3: mural nodule; ROI-4: contralateral normal cerebellar parenchymal tissue.

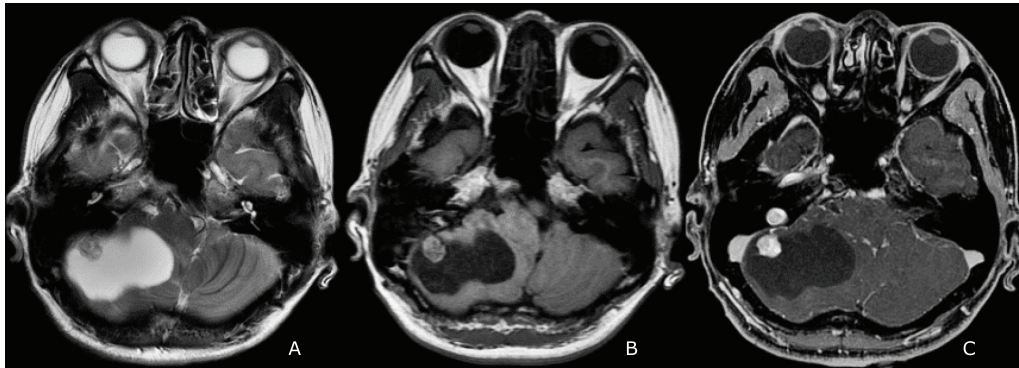


Figure 2. MRI of the brain for the patient with hemangioblastoma.

The lesion located in the right cerebellum and presented a large cyst with a solid mural nodule. A: axial T2 weighted imaging; B: axial T1 weighted imaging; C: axial enhanced T1 weighted imaging.

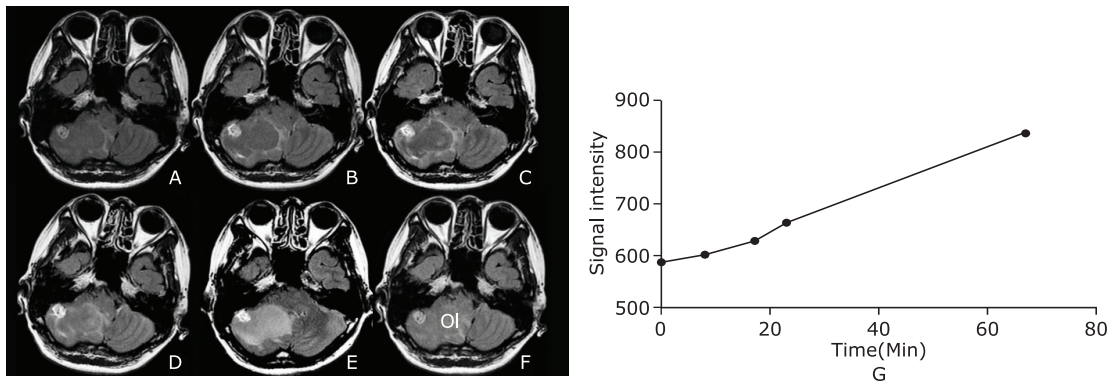


Figure 3. Plain and enhanced T2 fluid attenuated inversion recovery (T2-FLAIR) imaging of the brain for the patient with hemangioblastoma.

The most part of the mural nodule was not enhanced, and the peri-nodule presented obvious enhancement after contrast administration. The cyst part showed gradual enhancement and reached the highest signal intensity at 67 minutes after contrast administration. A: plain T2-FLAIR; B: enhanced T2-FLAIR at 5.6 minutes after contrast administration; C: enhanced T2-FLAIR at 17 minutes after contrast administration; D: enhanced T2-FLAIR at 23 minutes after contrast administration; E: enhanced T2-FLAIR at 67 minutes after contrast administration; F: region of interest (ROI) placed on the cystic part of the tumor; G: time—signal intensity curve of the cyst part in the tumor.

trast administration. However, the enhanced signal of cyst wall disappeared after 67 minute of contrast administration (Fig. 4E).

DCE-MRI revealed that the cyst wall, which showed no enhancement on post-contrast T1WI and evident enhancement on enhanced T2-FLAIR, presented obviously high signal on Ktrans mapping (Fig. 5C). Part of the solid mural nodule also presented slightly high signal on Ktrans mapping (Fig. 5F).

The quantitative DCE-MRI demonstrated that both the cyst wall and mural nodule presented high Ktrans, Kep and Ve values, and low Vp value compared with the contralateral normal cerebellar tissues (Table 1). Cyst wall showed a low Ktrans and Kep value, a high Ve and Vp value compared with mural nodule (Table 1).

At last, she was preliminarily diagnosed with

hemangioblastoma based on these MR imaging findings. The lesion was surgical resected and the specimen was stained with hematoxylin-eosin staining and immunohistochemistry. The final pathological diagnosis was hemangioblastoma.

DISCUSSION

The imaging patterns of hemangioblastoma included four types:^{1, 6-7} (1) macrocyst form with small mural nodule; (2) microcyst form with solid components; (3) solid form; (4) simple cyst form. The microcyst form and macrocyst form are the most common hemangioblastoma types, and the former is easy to diagnose, while the latter is relatively difficult to diagnose in clinical practice. For the microcyst hemangio-

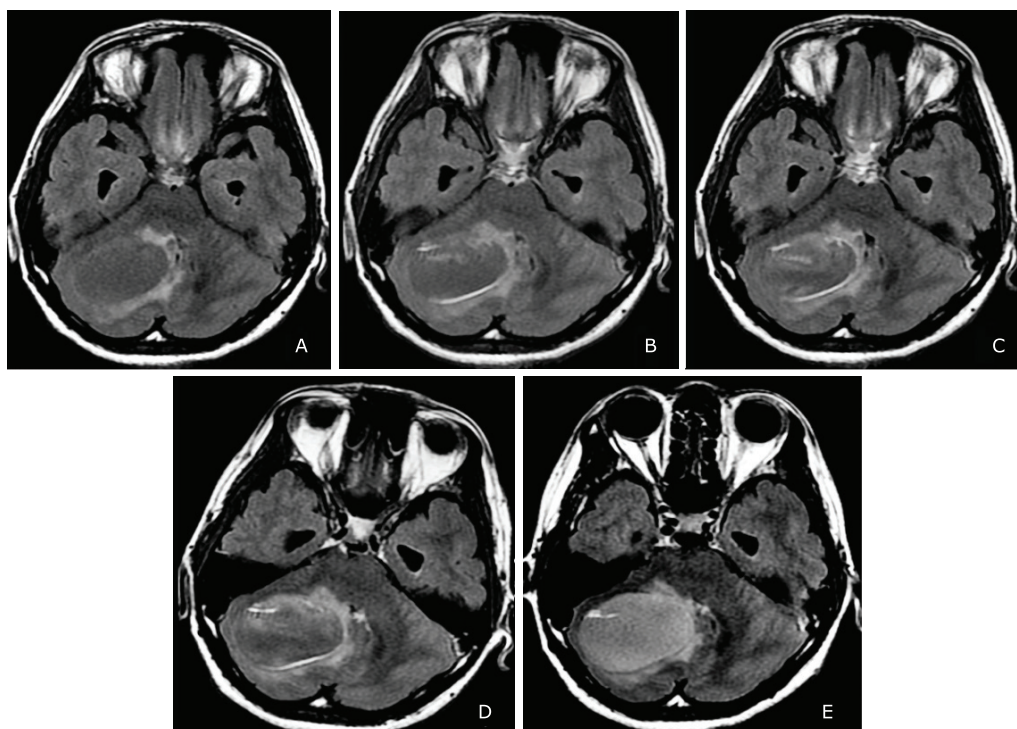


Figure 4. Plain and enhanced T2-FLAIR imaging of the brain for the patient with hemangioblastoma. The cyst wall of the tumor presented from 5.6 minutes to 23 minutes after contrast administration, and showed no obvious enhancement at 67 minutes after contrast administration. A: plain T2-FLAIR; B: enhanced T2-FLAIR at 5.6 minutes after contrast administration; C: enhanced T2-FLAIR at 17 minutes after contrast administration; D: enhanced T2-FLAIR at 23 minutes after contrast administration; E: enhanced T2-FLAIR at 67 minutes after contrast administration.

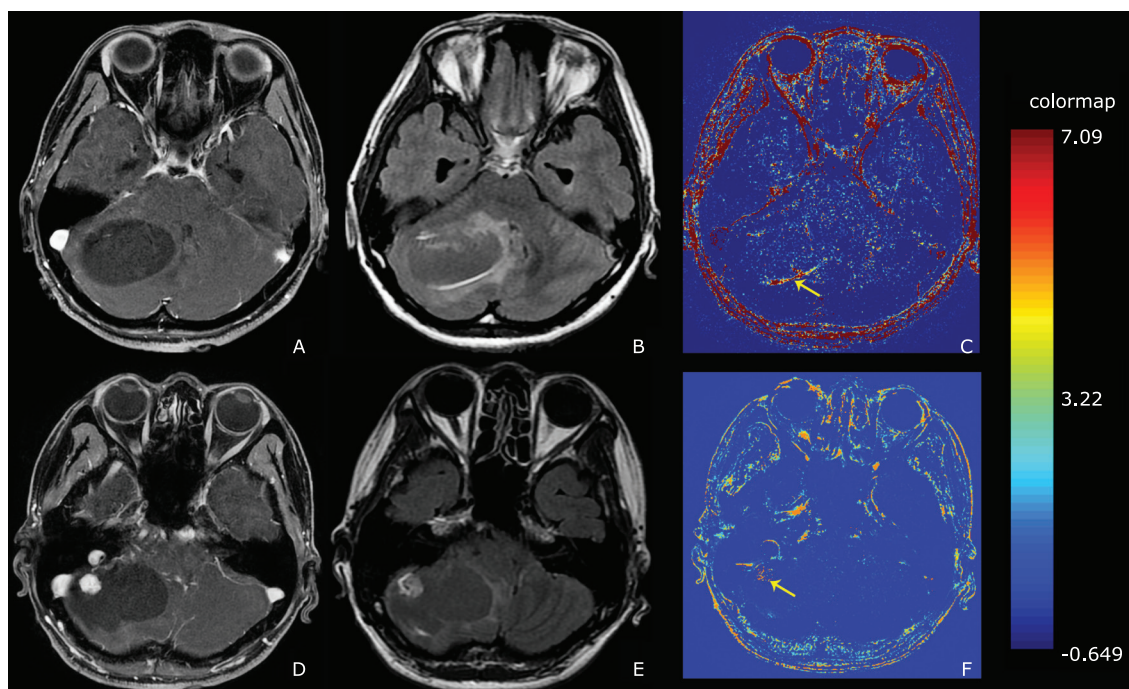


Figure 5. Ktrans mapping of hemangioblastoma. The enhanced cyst wall on post-contrast T2-FLAIR (B) without enhancement on post-contrast T1 weighted images (A) presented high signal on the Ktrans maps (C). The enhanced mural nodule on post-contrast T1 weighted images (D) without obvious enhancement on T2-FLAIR (E) presented slightly high signal on Ktrans maps (F). Yellow arrows indicate cyst wall on image C and mural nodule on image F.

Table 1. Quantitative results of dynamic contrast enhanced MRI on the brain of hemangioblastoma patient[§]

Items	Ktrans	Kep	Ve	Vp
Cyst wall (ROI-1)	0.404±0.462	0.216±0.270	0.634±0.427	0.644±0.407
Normal-1 (ROI-2)	0.028±0.082	0.085±0.179	0.202±0.270	0.793±0.233
Mural nodule (ROI-3)	0.936±1.854	0.708±1.188	0.262±0.439	0.635±0.483
Normal-2 (ROI-4)	0.016±0.042	0.028±0.096	0.218±0.298	0.913±0.152

§: Plus-minus values are means±SD.

blastoma, the cyst part presented no enhancement on post-contrast T1WI and significant enhancement on post-contrast T2-FLAIR images, which indicated that the blood-brain barrier of the cyst wall was impaired and minim contrast leaked into the cyst.³ For the macrocyst hemangioblastoma, the cyst wall showed no enhancement on post-contrast T1WI and obvious enhancement on post-contrast T2-FLAIR images in the current study. However, the neuromechanism of the enhancement on T2-FLAIR has not been elucidated in detail up to now.

The current study demonstrated that cyst wall of the lesion presented significant enhancement on T2-FLAIR without enhancement on post-contrast T1WI, which might be associated with the alteration of the Ktrans value.⁸ Further quantitative DCE-MRI demonstrated that the enhanced cyst wall had a high Ktrans, Kep and Ve Values compared with the normal brain tissues, which might suggest that part of the contrast transferred from plasma to EES. Therefore, the cyst wall might have a low contrast concentration and presented enhancement on T2-FLAIR images. In the delayed time points (67 minutes after contrast administration), the cyst wall did not show enhancement on T2-FLAIR, which indicated that the increased contrast concentration suffered from T2 signal decrease,⁸ or the decreased contrast agent fluxing into the cyst suffered from T1 signal decrease.⁸ This imaging evidence, early enhanced cyst wall on T2-FLAIR, might provide more valuable diagnostic information for macrocyst hemangioblastoma.

The enhanced nodule on T1WI showed no evident enhancement on post-contrast T2-FLAIR and obvious enhancement on post-contrast T1WI, which indicated that the nodule had a rich blood supply and a relative high contrast concentration.⁸ Compared with the cyst wall, the mural nodule had a relative high Ktrans, Kep and Ve Values as compared with normal brain, which might generate the relatively high contrast concentration and result in no enhancement on post-contrast T2-FLAIR by shortening T2 signal.⁸

In our previous research,³ the cyst did show evident enhancement after immediate contrast administration. However, the cyst presented a gradual enhancement, especially on 67 minutes after the contrast administration in the current study. Delayed enhancement of the cyst on T2-FLAIR might be another important imaging evidence, which might be helpful for the diagnosis of the macrocystic hemangioblastoma.

The limitation of this study was: (1) The current study only includes one hemangioblastoma patient, and a large sample size would be needed in the future study; (2) DCE-MRI was performed only for 5.6 minutes, and the longer dynamic enhanced time might provide more valuable information to understand the delayed enhancement of the cyst.

In conclusion, early enhancement of cyst wall and delayed enhancement of cyst might provide some valuable diagnostic information for cystic hemangioblastoma.

Conflicts of interest statement

The authors declare that they have no competing interests.

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多参数磁共振成像诊断小脑血管母细胞瘤 1 例报告

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关键词: 动态对比剂增强磁共振成像; 液体翻转恢复成像; 血管母细胞瘤; 诊断

摘要 本研究采用对比剂增强 T2 液体衰减翻转恢复成像及动态对比剂增强磁共振成像描述 1 例小脑血管母细胞瘤的影像学表现。T2 液体衰减翻转恢复成像显示右侧小脑可见一囊性病变并壁结节形成。注射对比剂 5.6 ~ 23 分钟后, 病变囊壁在 T2 液体衰减翻转恢复成像上明显强化, 动态对比剂增强磁共振成像证实囊壁及壁结节均较对侧正常小脑表现为高 K_{trans}、K_{ep} 及 V_e 值。注射对比剂后, 囊性成分在 T2 液体衰减翻转恢复成像表现为渐进性强化, 在 67 分钟时达到最高信号强度。总之, T2 液体衰减翻转恢复成像上囊壁早期强化可能是囊性血管母细胞瘤的特征性影像学表现, 有助于血管母细胞瘤的术前早期诊断。