The diagnosis of a large cavernous malformation may be challenging because its imaging appearance is variable. Here we reported a 22-year-old man with a large mass in the left side temporal lobe. Computed tomography showed a high density intra-axial mass with perifocal edema in left side temporal lobe. Cystic component, a tiny calcified spot and partial contrast enhancement of this lesion were also noted. Magnetic resonance imaging disclosed this mass was measured about 4.9 × 4.0 × 4.2 cm in size. Intra-tumoral hemorrhage was noted on T1-weighted images. On T2-weighted images, the peripheral hypointense rim around this mass was shown, which also appeared clearly on susceptibility-weighted images. Surgical excision was performed and pathology confirmed the diagnosis of cavernous malformation. Susceptibility-weighted imaging (SWI) is a magnetic resonance (MR) technique that exploits the magnetic susceptibility differences of various tissues, such as blood, iron and calcification [3]. In this report, we describe the SWI findings of a large cavernous malformation and discuss the helpfulness of SWI for its evaluation.

CASE REPORT

A 22-year-old man suffered from sudden onset of seizure attack and transient loss of consciousness. Then he was brought to our emergency room. Computed tomography (CT) scan of the brain (Fig. 1) showed a high density intra-axial mass with perifocal edema in left side temporal lobe. Cystic component and a tiny calcified spot within this lesion were also noted. Post-contrast CT images showed partial contrast enhancement of this lesion. Magnetic resonance imaging (MRI) (MAGNETOM Symphony system of Siemens) disclosed this mass was measured about 4.9 × 4.0 × 4.2 cm in size. On T2-weighted images (Fig. 2a), it was heterogeneously hyperintense with peripheral hypointense rim. On T1-weighted images, some hyperintense lesions were noted within this mass, suggestive of intra-tumoral hemorrhage. On Gadolinium-enhanced T1-weighted images, the mass showed slightly heterogeneous enhancement. On SWI and its minimal intensity projection (minIP) images, it had “blooming” effect due to intra-tumoral hemorrhage and became mainly dark mixed with some hyperintense regions. The hypointense rim around this mass was clear (Fig.
2b-2c). The SWI phase images (Fig. 2d) revealed mixed bright and dark signal intensities within the lesion. The calcified spot was dark signal intensity. The patient was then admitted to our hospital and underwent craniotomy for removal of this mass. During operation, a 3 x 5 x 5 cm reddish gray mass was found over the left temporal lobe. This lesion was soft and encapsulated. Hematoma within the lesion was also noted. The specimen was sent to the department of pathology. Microscopic study (Fig. 3) showed many dilated thin-walled venous channels with marked congestion and thrombus formation. Hemosiderin-laden macrophages indicating old hemorrhage can also be discerned. From the histological features, the diagnosis of cavernous malformation was rendered. The patient did well postoperatively and was then discharged 12 days later.

**DISCUSSION**

SWI is a MR technique that exploits the magnetic susceptibility differences of various tissues, such as blood, iron and calcification [3]. It consists of using both magnitude and phase images from a high-resolution, three-dimensional (3D) fully velocity-compensated gradient echo sequence [4]. Filtering of original phase images can reduce aliasing artifacts which arise predominantly from air–tissue interfaces and background field inhomogeneities. Phase mask is created from the filtered phase images and multiplied with the magnitude images to create a SWI, which can enhance the visualization of vessels or microbleeds. The minIP images can be used to show the continuity of the venous vascular system and help to differentiate bleeds that are not connected to major veins [5].

Until recently, most diagnostic MR imaging relied only on the reading of magnitude information, and the phase information was usually ignored and discarded before even reaching the viewing console [6]. However, phase images contain a wealth of information about local susceptibility changes between tissues [3, 7], which can be useful in measuring iron content [7] and differentiation of calcification from hemorrhage [8, 9]. Calcium and oxyhemoglobin have no unpaired electrons and therefore they are diamagnetic. Deoxyhemoglobin, methemoglobin and hemosiderin have unpaired electrons and they are paramagnetic [5]. The diamagnetic substances generate magnetic fields that subtract from the external main magnetic field, whereas the paramagnetic substances generate magnetic fields that additively combine with the external magnetic field [4]. The diamagnetic substances show negative phase shift and the paramagnetic substances show positive phase shift in left-handed MR systems, such as the Avanto system of Siemens (Erlangen, Germany) [9] (We used MAGNETOM Symphony system of Siemens in our hospital). Therefore, phase images can differentiate calcification from hemorrhage according to their opposite phase shifts [10]. In the phase images of our case, the calcified spot was dark signal intensity, in contrast to the high signal intensity of the veins and hemorrhage (Fig. 2d).

The diagnosis is mostly straightforward in typical cases of cavernous malformation. However, the diagnosis may be challenging in a large cavernous malformation, which is a rare lesion [2]. The imaging appearance of a large cavernous malformation is variable, ranging from completely cystic lesions to those resembling neoplasms with striking contrast enhancement and mass effect, and finally to heterogeneous lesions with peripheral hemosiderin rim and without significant contrast enhancement and mass effect [2]. In our case, the preoperative diagnosis of cavernous malformation...
Figure 2. **a.** Axial T2-weighted images (TR/TE: 3840/92 ms). This mass is heterogeneously hyperintense with peripheral hypointense rim (thin white arrow). **b.** SWI (2b) and its minIP images (2c)(TR/TE: 50/40 ms, flip angle=15°) demonstrates that this mass had “blooming” effect due to intra-tumoral hemorrhage and became mainly dark mixed with some hyperintense regions. The hypointense rim around this mass is clear (thick white arrow). **d.** Phase images of SWI (TR/TE: 50/40 ms, flip angle=15°), mixed bright and dark signal intensities within the lesion was noted. The calcified spot was dark signal intensity (white arrowhead), in contrast to the high signal intensity of the straight sinus (thick black arrow).
was considered because of the presence of hemosiderin rim, blood breakdown products, calcification and surrounding gliosis.

Probably related to the blood stagnation phenomenon and chronic microhemorrhages, cavernous malformations contain deoxyhemoglobin or hemosiderin, which generates susceptibility effects and causes a decrease in signal intensity [11]. These signal-intensity abnormalities are better evaluated with SWI.

Otherwise, SWI exploits different relaxation rates between venous and arterial blood as well as the phase changes caused by the susceptibility differences between oxygenated and deoxygenated hemoglobin. Therefore, this technique is exquisitely sensitive to these small differences and enhances the signal intensity-intensity loss in the venous circulation [12]. Hence, the margin of the cavernous malformation is defined better with SWI technique than T2*-weighted images [13], and the hemosiderin rim around the cavernous malformation appears clearly as a hypointense signal intensity on SWI [14]. In our case, the same finding was also noted (Fig. 2b, 2c). Because of better display of the surrounding hemosiderin rim, SWI can be helpful in differentiating cavernous malformation from other hemorrhagic tumor. Phase images of cavernous malformation reveal mixed bright and dark signal intensities within the lesion, owing to strong, irregular phase variations caused by the hemosiderin [9, 15]. Similar findings were observed in our case on phase images (Fig. 2d).

In conclusion, the diagnosis of a large cavernous malformation may be challenging. However, SWI can help to confirm the diagnosis of cavernous malformation in patients presenting with cerebral hemorrhage because of its high degree of sensitivity in identifying venous structures and blood products.

**REFERENCE**


磁化率加權影像用於評估大型海綿狀畸形：
病例報告

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大型海綿狀畸形的診斷是具有挑戰性的，因為它的影像表現多變。我們報告一個 22 歲男性在左邊顳葉有一個大腫瘤。電腦斷層發現一個有病灶周圍水腫之高密度腫瘤在左邊顳葉。囊狀成份，一小鈣化點及部分病灶顯影也被注意到。在核磁共振影像之下，這個腫瘤的大小大約是 4.9 × 4.0 × 4.2 公分。在 T1 加權影像可見腫瘤內出血。腫瘤周圍的低訊號邊緣可見於 T2 加權影像且在磁化率加權影像表現更清楚。經外科切除後，病理確認了海綿狀畸形的診斷。磁化率加權影像是一種利用不同組織間磁化率差異的技術。因為它對於區別血液、鐵質及鈣化有高度的敏感性，所以可以用來幫助診斷海綿狀畸形在腦出血的病人。