**Subarachnoid Hyperdensity Following Aneurysm Embolization in Renal Failure**

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**Postprocedural seizure with impaired consciousness and asymmetric subarachnoid hyperattenuations on computed tomography (CT) scans suggests periprocedural perforation of an aneurysm or contrast material–induced encephalopathy (CMIE).** We now report the case of a 59 year-old woman with a history of end-stage renal disease and multiple intracranial aneurysms who underwent embolization with Guglielmi detachable coils. Fourteen hours after the intervention, the patient had a general seizure, with subsequent impairment of consciousness. Non-enhanced CT scans revealed diffuse subarachnoid hyperattenuation, more prominent in the left frontoparietal region. The patient received emergency hemodialysis. Post-dialysis CT demonstrated complete resolution of the hyperattenuation. In patients with end-stage renal disease, early post-embolization hemodialysis is necessary to avoid contrast material–induced encephalopathy and to clarify the potentially confusing complication of procedural rebleeding.

When an episode of seizure occurs after GDC embolization with subarachnoid hyperattenuations on CT scans, it is important to differentiate aneurysmal rupture or encephalopathy induced by contrast material because that management and prognosis are significantly different between those diagnoses. Here we describe an educational case with contrast medium-induced encephalopathy (CMIE).

**CASE REPORT**

A 59 year-old woman with a history of end-stage renal disease undergoing regular hemodialysis had multiple incidentally found intracranial aneurysms on the left middle cerebral artery and the basilar tip. The patient underwent embolization by using Guglielmi detachable coils (GDC) for the left middle cerebral artery aneurysm. The same management was performed for the basilar tip wide neck aneurysm with the assistant of a neuroform microstent (Fig. 1). Under general anesthesia, partial embolization was achieved and the procedure was uneventful. Scheduled post-angiographic dialysis was postponed due to the bleeding risk from the usage of dual antiplatelet and anticoagulative agents (aspirin 100mg PO QD and clopidogrel 75mg PO QD, since 3 days before procedure to 2 months after procedure; heparin 3000U IV during procedure), as a standard protective protocol with the neuroform microstent.

Fourteen hours after the intervention, the patient had a general seizure with subsequent impairment of consciousness. Non-enhanced computed tomography (CT) revealed bilateral diffuse subarachnoid hyperattenuation, and was more prominent in the left frontoparietal region (Fig. 2). The patient received emergency hemodialysis. Post-dialysis CT demonstrated complete resolution of the hyperattenuation (Fig. 3). Brain magnetic resonance imaging and magnetic resonance angiography performed on the same day revealed no recent

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DIsCUSSION

Major complications of embolization using GDC include aneurysm rebleeding and thromboembolic events. It has been reported that 5-10% of patients with subarachnoid hemorrhage have seizures at the onset of bleeding [1]. According to the clinical presentation and imaging findings, the first consideration was hemorrhagic complications due to aneurysmal rupture. In addition, the same clinical presentation and radiological appearance might result from encephalopathy due to the toxicity of the contrast medium. The focal, asymmetric hyperdensity of the subarachnoid space in the CT scan, although it highlights the possibility of aneurysmal rebleeding, can be indistinguishable from hemorrhage and contrast medium which increase leakage across the blood-brain barrier during the pathologic process. The outcome and management of these two different disease entities would vary considerably.

In the past 20 years, four cases have been reported that are similar to our case; that is, they also had increased density in the subarachnoid space mimicking SAH (Table 1). Three of them were found after coronary angiography [2-4] and one following spinal angiography [5]. Those patients all presented with neurological symptoms immediately after the angiography. Our patient was the only reported case who experienced a delayed seizure following cerebral angiography and GDC embolization for intracranial aneurysms. The clinical history of intracranial aneurysms is associated with a high risk of subarachnoid hemorrhage. It increases the difficulty of differentiating between SAH and toxicity induced by the contrast medium.

Emergency CT studies are useful for detecting post-procedural rebleeding or thromboembolic events. However, the differential diagnosis between contrast medium and blood extravasation is not straightforward. Attenuation values of contrast material in the cerebral subarachnoid fluid are typically much higher than those observed in subarachnoid blood, which is usually less than 100 Hounsfield units (Hu) [6]. In our case, the attenuation values measured in the subarachnoid space were about 80-110 Hu. Furthermore, the clearance rate of contrast medium and blood was also different. In the 4 cases reported, the CT scan obtained 1 day after the event revealed a marked decrease (>50%)

Figure 1. Conventional angiography revealed cerebral aneurysms: one slightly wide-neck aneurysm in the left MCA M1/2 junction and another smaller one in the left anterior cerebral artery A1/2 junction.
Figure 2. a. Non-enhanced axial CT obtained 1 hour after the patient’s first seizure shows bilateral hyper-attenuations in the internal carotid and middle cerebral arteries, as well as in the basilar arteries. The metallic artifact over the left temporal area is due to previous deployment of a Guglielmi detachable coil. b. Image shows subarachnoid hyper-attenuation in the left frontoparietal region.

Table 1. Summary of 5 cases of contrast medium-induced encephalopathy

<table>
<thead>
<tr>
<th>Patient no./age (year)/gender</th>
<th>Year of report [reference]</th>
<th>Underlying disease</th>
<th>Procedure</th>
<th>Contrast medium</th>
<th>CT findings</th>
<th>Treatment</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/71/F</td>
<td>1998 [5]</td>
<td>Multiple spinal cord hemangioblastomas</td>
<td>Spinal angiography</td>
<td>360ml ioxaglate</td>
<td>Diffuse hyperdensity within the subarachnoid space in the sulci and throughout the basal cisterns</td>
<td>Conservative treatment</td>
<td>The neurologic symptoms resolved 4 days later</td>
</tr>
<tr>
<td>2/73/F</td>
<td>1999 [2]</td>
<td>Coronary artery disease, peptic ulcer, hypertension, hypercholesterolemia</td>
<td>Coronary angiography and stent placement</td>
<td>350ml iohexol; 800ml diatrizoate meglumine</td>
<td>CSF and cortical hyperdensity greater on the right</td>
<td>Conservative treatment</td>
<td>Most of contrast medium cleared within 24 hours</td>
</tr>
<tr>
<td>3/67/M</td>
<td>1993 [3]</td>
<td>Hypertension, hypercholesterolemia, exertional angina</td>
<td>Coronary angiography</td>
<td>400ml renografin</td>
<td>Contrast in the cerebral circulation with marked enhancement of the basal ganglia, thalami, cortical gyri, and subarachnoid space</td>
<td>Conservative treatment</td>
<td>Neurologic examination recovered at day 46 except for mild cognitive dysfunction</td>
</tr>
<tr>
<td>4/49/M</td>
<td>1996 [4]</td>
<td>ESRD on hemodialysis, unstable angina</td>
<td>Coronary angiography and stent placement</td>
<td>90ml and 610ml renografin</td>
<td>Diffuse hyperdensity in the left frontal and left occipital gyri, with little surrounding edema or mass effect</td>
<td>Hemodialysis</td>
<td>No abnormalities on CT at 10 days after procedure</td>
</tr>
<tr>
<td>5/59/F</td>
<td>2009 (present case)</td>
<td>ESRD, cerebral aneurysms</td>
<td>Cerebral angiography and GDC embolization</td>
<td>80 ml angiografin</td>
<td>Diffuse subarachnoid hyperattenuation, more prominent in the left frontoparietal region</td>
<td>Hemodialysis</td>
<td>No neurologic sequelae 9 days later</td>
</tr>
</tbody>
</table>
Subarachnoid hyperdensity following aneurysm embolization

of the high attenuation in the subarachnoid space. Under conditions of normal renal function, most of the contrast medium can be cleared, while less than 50% of blood can be removed from the subarachnoid space within 24 hours [7]. Moreover, the contrast medium can also be removed by hemodialysis. We believe that a non-enhanced CT scan can help the physician make the correct diagnosis on the basis of attenuation values and follow-up imaging, and avoid unnecessary procedures for patients.

Ionic contrast medium-induced encephalopathy is thought to involve damage of the blood-brain barrier. Once contrast medium permeates the brain, it can cause cortical dysfunction by increasing neuronal excitability [8]. Overdosage of contrast medium increases the risk of neurotoxicity, especially in cranial angiography for aneurysm embolization. This adverse effect is aggravated by selective injection of contrast medium in vessels that are targeted for embolization of an aneurysm. The regionally high contrast medium concentration has a direct impact on the blood-brain barrier of particular arteries and results in neurological symptoms. Aneurysm bleeding during the procedure may also result in asymmetrical subarachnoid hyperattenuation on CT scan and cannot be totally excluded. However, the uneven procedure course of patient makes it less likely.

In the 4 reported cases, 3 with normal functions received a high dose of contrast agent during the procedure, more than the suggested maximal dosage (200 ml). The neurologic deficit gradually resolved after conservative treatment. Another patient with chronic renal insufficiency also received an overdose of contrast medium [4]. After emergency hemodialysis, he had no more progressive neurologic defects except for an additional myocardial infarction. However, our patient received a total of 80 ml of diatrizoate meglumine (Angiografin 65%) during the procedure and the CMIE still occurred. In renal insufficiency, the clearance of contrast medium is dependent upon the extrarenal system, and the half-life would be increased to 47-140 hours [9]. Even using less than the suggested maximal dosage of contrast medium, it creates pressure for those patients with end-stage renal disease. The effect of dialysis on the clearance of contrast agents has been studies, and it was consistently demonstrates hemodialysis as an effective method of clearing these agents. The mechanism of contrast clearance in cerebrospinal fluid (CSF) remain unclear in literature but it is hypothesized that the CSF ultimately percolates

Figure 3. a. b. Follow-up CT scan obtained 2 hours after hemodialysis shows complete resolution of intravascular and subarachnoid hyper-attenuations, along with a Neuroform microstent that was used for the wide-necked basilar tip aneurysm.
back up over the convexities of the hemispheres, where it is resorbed by the arachnoid villi into the intravascular space [10], and therefore, the hemodialysis may be helpful to the removal of residual contrast material in CSF. Post-procedure hemodialysis for patients with chronic renal insufficiency is suggested.

**CONCLUSION**

The present case demonstrates the unusual complication of CMIE after embolization of an intracranial aneurysm. The clinical presentation and imaging findings are similar to those found in SAH. It follows a relatively benign course and a majority of patients with normal renal function recover without any residual neurologic deficits. However, for patients with ESRD, early post-embolization hemodialysis is necessary to avoid this situation and help to clarify the potentially confusing complication of procedural rebleeding.

**REFERENCES**

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腎臟衰竭病患接受動脈瘤栓塞後在電腦斷層之蜘蛛網膜下腔高密度病灶影像表現

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在動脈瘤栓塞後發生之痙攣合併意識受損，並在電腦斷層看見不對稱之蜘蛛網膜下腔高密度病灶，可能是由於栓塞過程中併發動脈瘤破裂，或者是顯影劑造成之神經病變。我們報告一位患有末期腎病變之 59 歲女性，合併多發性的顱內動脈瘤並接受白金線圈栓塞。術後十四小時，病人發生痙攣現象併有意識受損。未顯影之電腦斷層顯示雙側瀰漫性蜘蛛網膜下腔之高亮度病灶，尤以左側顳頂葉附近為主。病人接受緊急洗腎，其後追蹤電腦斷層顯示此病灶完全消失。在末期腎病患，動脈瘤栓塞術後早期洗腎是相當重要的，可以避免顯影劑導致神經病變，並且可與術後出血做一明確區分。