Serious Blood-Brain Barrier Disruption after Coil Embolization of Unruptured Intracranial Aneurysm: Report of Two Cases and Role of Immediate Postembolization CT Scan

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Abnormal contrast enhancement on brain computed tomography (CT) scan after diagnostic or interventional angiography is not rare, and has been known to be induced by temporary blood-brain barrier (BBB) disruption from contrast media. Furthermore, it has been regarded as clinically subtle, but reported to have no symptom or mild transient symptoms. However, we recently experienced two cases of serious BBB disruption during the acute period after coiling of an unruptured intracranial aneurysm. One patient presented with an unruptured paraclinoid internal carotid artery (ICA) aneurysm on the right and the other with an unruptured right suprachinoid ICA aneurysm. Both patients showed similar findings on immediate postembolization CT scan and clinical courses after coiling. Typical radiological, clinical characteristics of BBB disruption were described. In addition, the role of immediate postembolization CT scan are also discussed.

Key Words: Aneurysm ∙ Blood-brain barrier ∙ Coil ∙ Embolization.

INTRODUCTION

Nonionic iodinated contrast media (CM) are generally used for diagnostic and interventional cerebral angiography. Several cases with minor complications resulting from nonionic CM have been reported. 5-7,9 Regarding the adverse events of CM, abnormal contrast enhancement on brain computed tomography (CT) scan is most common event and it is reported to be encountered up to 43% in clinical practices. 7 Appearance of these patterns on CT scans can be various such as cortical, subarachnoid, intraventricular, and striatal enhancement. 2-3 Temporary disruption of blood-brain barrier (BBB) permeability has been the primary explanation for the abnormal CT findings. 2-7,9 Such abnormal enhancement after angiography had mostly reported no symptoms, or only mild transient symptoms. However, we recently experienced two patients of life-threatening BBB disruption who revealed typical radiological findings in immediate postembolization CT scan and simultaneously showed serious neurological deterioration, particularly after coiling of an unruptured cerebral aneurysm.

CASE REPORT

Case 1
A 58-year-old female was admitted for coiling of an unruptured paraclinoid internal carotid artery (ICA) aneurysm on the right. The aneurysm was incidentally found on the screening magnetic resonance imaging (MRI) for evaluating nonspecific headache. She had no past medical history. The coiling procedure was uneventful (Fig. 1A, B) under systemic heparinization which was administered as a 3000-IU bolus intravenously, and its duration was 80 minutes; the patient’s body weight was 56 kg, therefore, 3.45 cm³/kg of nonionic water-soluble iodinated contrast material (Visipaque 320; Amersham Health, Oslo, Norway) was used. The immediate postembolization CT scan showed diffuse cortical hyperintensity and some gyral swelling in the right frontoparietal lobe, which were suggestive of CM induced BBB disruption (Fig. 1C, D). However, the patient was neurologically stable without headache. At four hours following the procedure, she deteriorated neurologically to GCS 12 with left hemiparesis (4/5). MRI showed multiple small high signals on diffusion...
at discharge.

**Case 2**

A 61-year-old female was hospitalized for coiling of an unruptured supraclinoid ICA aneurysm on the right which was found on the coiling angiography at 2 months before. Then, the patient was presented with subarachnoid hemorrhage from rupture of basilar top aneurysm and treated with coil embolization. She had no previous medical history. The coiling procedure using a balloon assisted technique (4×10 mm HyperGlide, ev3, Plymouth, Minnesota, USA) was uneventful under 3000-IU-bolus of intravenous heparinization (Fig. 2A, B), and its duration was 70 minutes; the patient’s body weight was 54 kg, therefore, 3.92 cm$^3$/kg of the same CM (Visipaque 320) was used. The immediate postembolization CT scan showed strong cortical hyperintensity on the right frontoparietal lobe, and high density in the right striatum (Fig. 2C, D). The CT scan was typically suggestive of CM induced BBB disruption, which seemed more serious than case 1. Despite she was neurologically stable without headache at the time, she was carefully monitored considering the CT findings. As expected, this patient also deteriorated neurologically to GCS 13 with left hemiparesis (4/5) at 6 hours from coiling. The neurologic deterioration peaked at GCS 8 with left hemiparesis (2/5) at approximately 24 hours after coiling. DWI in MRI showed within normal limit. With conservative care including lowering of the patient’s systolic BP was continued and the patient showed neurological improvement at three days after coiling.

**DISCUSSION**

Abnormal contrast enhancement on brain CT scan following diagnostic and interventional angiography is not rare, and transient disruption of BBB has
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been the main explanation for the situation\(^1,^2,^4,^5,^7,^8,^9\). Various factors can induce temporary BBB disruption, including CM, balloon inflation during remodeling technique, advanced age, and hypertension\(^6\). Among these, iodinated CM has been regarded as the most constant and important factor influencing BBB permeability\(^6\). The CM used in these patients are Visipaque; dimeric, isosmolar, nonionic, water-soluble, radiographic CM and reported to be relatively safe and low side effect\(^7\). Besides, there have been several reports of BBB disruption from Iohexol (Omnipaque 300; Amersham Health, Cork, Ireland), Iopromide (Ultrasound; Schering AG, Berlin, Germany), Ioversol (Optiray; Mallinckrodt Medical, St. Louis, USA), Iopamidol (Isovue 370; Bracco Diagnostics, Princeton, USA), and Iodixanol (Visipaque 320)\(^2,^5,^7,^9\). However, in those reports, the mechanism of CM induced BBB disruption was not focused on the kind of CM, but the osmolarity, chemical structure, and speed of injection of CM\(^7\). Furthermore, it has been mostly reported as clinically subtle, even symptomatic, the cases are not considered to be serious no more than transient global amnesia, cortical blindness, and seizure\(^3,^4\). However, this study presented two cases of life-threatening BBB disruption which could have been originated by the CM, particularly after coiling of unruptured intracranial aneurysm. To our knowledge, this is the first report of CM induced, serious BBB disruption after coiling of unruptured cerebral aneurysm.

Since January 2006, we have performed immediate post-embolization CT scan for early detection of procedural complications including BBB disruption. Based on our experiences, immediate postembolization CT scan played a role in detection of CM induced BBB disruption. In case 1, differential diagnosis of the patient’s neurologic deterioration was difficult among several possible causative clues, including abnormal enhancement on postembolization CT scan, multiple microinfarctions on DWI, and diffuse narrowing of cortical branches of the MCA on follow-up DSA. On the contrary, in case 2, even though the patient was neurologically stable after coiling, we could predict the patient’s deterioration based on immediate postembolization CT findings, which showed strong cortical hyperintensity on the right frontoparietal lobe and high density in the right striatum. Without immediate postembolization CT scan, we could not obtain the most important evidence for diagnosis of BBB disruption. According to previous report, iodine contents in cerebrospinal fluid showed rapid decrease to near zero within two days\(^9\). Both patients in this study showed either weak or no contrast enhancement on next morning CT scans, which were performed at 15 hours and 17 hours after coiling.

CONCLUSION

This study presents two cases of serious BBB disruption, which supposed to be caused by CM, particularly after coiling of unruptured intracranial aneurysm. Based on these cases, CM induced BBB disruption could be a possible cause of a patient’s neurologic deterioration during the acute period after coil embolization. In addition, immediate postembolization CT scan may play a role in terms of early detection of CM induced BBB disruption.

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