Parent Artery Stenosis and Visual Disturbance after Balloon-assisted Coil Embolization of an Unruptured Cerebral Aneurysm: A Case Report

Masanori Goto, Hirokuni Hashikata, Hiroki Toda, and Kouichi Iwasaki

Objective: A rare case of parent artery stenosis and visual disturbance after balloon-assisted coil embolization for an unruptured cerebral aneurysm is reported.

Case Presentation: A 63-year-old woman underwent successful coil embolization of an incidental cerebral aneurysm using a balloon-assisted technique. The aneurysm was located in the right internal carotid artery. Her treatment course was uneventful, and she was discharged without any neurological deficits. Follow-up angiography after 9 months showed severe parent artery stenosis without aneurysm recurrence. However, she had a visual disturbance, and MRI showed edema around the treated aneurysm at the same time. Judging from the results of several metal patch tests, the platinum coils caused this pathology, and oral steroids and antihistamines were administered. This treatment improved her parent artery stenosis, but her visual disturbance persisted.

Conclusion: Although parent artery stenosis after coil embolization using balloon-assisted technique of a cerebral aneurysm in the chronic phase is rare, we should consider the possibility of metal allergy.

Keywords ▶ coil embolization, cerebral aneurysm, complication, stenosis, allergy

Introduction

Many cases of parent artery stenosis and occlusion after stent-assisted coil embolization (SAC) of aneurysm have been reported, but fewer cases of parent artery stenosis after conventional coil embolization have been reported. On the other hand, implants made of various materials are used in surgery, and foreign body reactions to implants have been reported in each field. In interventional radiology, cases of inflammatory reactions of the surrounding tissue after coil embolization of aneurysm, especially in cases using bioactive coils, and symptomatic allergic cases, such as white matter change in the parent artery-perfused region after SAC, have been reported. We encountered a patient with aneurysm in whom the course after balloon-assisted coil embolization was smooth with no abnormality, but severe stenosis of the parent artery and symptomatic edematous change around the aneurysm occurred in the chronic phase. Since no similar case has previously been reported, we report the case with a literature review.

Case Presentation

The patient was a 63-year-old female. Right internal carotid artery (ICA) aneurysm was incidentally pointed in close examination by head MRI for numbness of the fingers and she was referred to our department. She had no past or familial medical history to be mentioned other than hypertension. An antihypertensive drug was the only oral medication and she had no history of allergy. On the first examination, no finding of neurologic deficit was noted, and chronic ischemic change was detected in the white matter on head MRI. On head MRA, the aneurysm was present in C2 of the right ICA in the medial posterior direction, the maximum diameter was 9 mm, and it contacted...
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the lower surface of the optic nerve. No abnormal intensity was detected around the aneurysm (Fig. 1A). On angiography, the aneurysm measured 9.3 × 7.5 mm, the neck width was 4 mm, and bleb was present at the tip (Fig. 2A and 2B). The patient requested treatment and coil embolization of the aneurysm was planned.

Endovascular surgery
Aspirin 100 mg/day and clopidogrel 75 mg/day were administered from 2 weeks before treatment. In surgery, the right femoral artery was punctured and a 7Fr long sheath was placed under local anesthesia, and systemic heparinization was applied. 7Fr Roadmaster (Goodman, Aichi, Japan) was advanced to the neck of the ICA, and then Hyperglide 4 × 15 mm (Medtronic, Minneapolis, MN, USA) was placed in the neck of the aneurysm. Steam-shaped Headway 1.7Fr 150 cm STR (Microvention Terumo, Tokyo, Japan) was guided to the almost center of the aneurysm using CHIKAI 14 200 cm (Asahi Intecc, Aichi, Japan). After framing using Target 360 standard 9 mm × 30 cm (Stryker, Kalamazoo, MI, USA), coil embolization was applied using Target 360 standard 8 mm × 20 cm, Complex 18 8 mm × 20 cm (Microvention Terumo), Orbit Galaxy complex fill 6 mm × 10 cm, 6 mm × 10 cm, and 5 mm × 10 cm (Johnson & Johnson, Fremont, CA, USA), and Deltaplush 3 mm × 6 cm, 3 mm × 4 cm, 2 mm × 3 cm, and 2 mm × 2 cm (Johnson & Johnson), 10 coils in total, appropriately using the balloon-assisted technique. The coil loop slightly protruded into the parent artery from the distal side of the neck in the final phase, but no finding of thrombus formation was noted, and surgery was completed with slight residual blood inflow on the proximal side of the neck (Fig. 2C and 2D).

Postoperative course
The patient was discharged after confirming the absence of neurologic deficit signs or novel cerebral infarction on head MRI. Clopidogrel was withdrawn 1 month after treatment, and the course was asymptomatic at 3 months after treatment. No novel ischemic lesion was detected on head MRI during this period, blood flow signal in the aneurysm disappeared, and patency of the parent artery was favorable. Therefore, aspirin was also withdrawn. Mild stenosis was observed in the distal region with coil loop protrusion on angiography 6 months after treatment (Fig. 2E and 2F), but no change was noted in hemodynamics and the condition was asymptomatic. Thus, course observation was selected. However, right eye-dominant homonymous visual field defect appeared 9 months after treatment (Fig. 3) and severe stenosis of the ICA of the aneurysm neck and reduction of blood flow signal of the right ICA were noted on head MRA. Moreover, severe edematous change was noted along the right optic nerve located close to the aneurysm after embolization and it reached the optic tract on head MRI (Fig. 1B and 1C). Parent artery stenosis was diagnosed...
and administration of aspirin 100 mg/day and clopidogrel 75 mg/day was re-started. On angiography, severe stenosis progressed from theICA C3 more proximal than the aneurysm neck including the full length of the aneurysm neck over the distal side of the neck (Fig. 2G and 2H). In addition, although antegrade blood flow to the distal side remained, it was markedly delayed and reduced and the distal side was perfused with blood flow from the anterior communicating artery and posterior communicating artery.

Contrast-enhanced CT of the trunk and carotid artery echo were performed, but no progression of atherosclerotic change or abnormal finding of thoracic and abdominal organs were observed other than parent artery stenosis of the aneurysm. No finding suggesting vasculitis or collagen disease was detected in blood samples, and no causative disease for the lesion was observed. Since not only parent artery stenosis but also perianeurysmal edematous change occurred, allergic reaction to the devices was suspected to be involved in the pathology. Thus, metal patch tests were performed and positive reactions to cobalt chloride, tin chloride, ferric chloride, chloroplatinic acid, and potassium dichromate, which are metals contained in the coil used in embolization, were noted. In addition, the eosinophil count increased from $190 \times 10^3/\mu L$ before treatment to $460 \times 10^3/\mu L$ after treatment, being more than double, suggesting involvement of delayed-type allergy to the coil in the pathology. Thus, in addition to the anti-platelet agents described above, administration of prednisolone (initial dose: 40 mg/day for 1 day, 20 mg/day for 2 days, 10 mg/day for 2 days, 5 mg/day for 3 days, maintenance dose: 2.5 mg/day) and fexofenadine was initiated. After initiation of drug administration, edematous change along the right optic nerve tended to regress with time on head MRI (Fig. 1D and 1E) and ICA stenosis improved while blood flow signal in the aneurysm remained absent on head MRA, with which ICA blood flow including that on the distal side improved to the level before the appearance of stenosis. The increased eosinophil count rapidly decreased and returned to the level ($130 \times 10^3/\mu L$) before treatment. No adverse effect of steroid developed and drug administration was continued for 1 year and 9 months including administration for another disease, but visual field defect protracted.

### Discussion

Two lesions: parent artery stenosis and symptomatic perianeurysmal edema, appeared at the same time in this patient.
and the severity was very high. To our knowledge, no case showing these pathologies simultaneously has been reported.

**Vascular stenosis after coil embolization of aneurysm**

Complications of coil embolization of aneurysm include coil protrusion into the parent artery and it occurs during treatment in many cases. Course observation is frequently selected when protrusion is not mobile and it has been reported that there was no difference due to coil protrusion in development of symptomatic cerebral infarction and neurological symptoms. Only a few cases of delayed parent artery stenosis induced by a coil which deviated into the parent artery during coil embolization have been reported and the deviated loop migrated toward the distal side during the course in both reports. In addition, it has been reported that the coil may be fixed to the vascular endothelium within 6 months and it occurred within 6 months after treatment in both reports. In a study in which edematous change was noted around the aneurysm after coil embolization of aneurysm in 8.9%, hydrocoil was used in all patients and all cases were asymptomatic, but occurrence of convulsive attack at 3 weeks and perianeurysmal edematous change at 3 months after treatment using bare platinum coils has been reported. Involvement of intra-aneurysmal thrombosing, inflammation, and cicatrization of the aneurysm wall in the thrombosing process, and wall thickening by vascular connective tissue is considered. The symptomatic reaction to the tissue around the aneurysm appeared 9 months after treatment in our patient, which was late compared with the timing in previous case reports excluding a chronic-phase case of symptomatic perianeurysmal edema which developed 8 years after the use of bioactive coils. Coils containing polyglutamic acid (PGA) were used in the final step of coil embolization and involvement of inflammation induced by these coils was considered, but the lesion progressed later than the time required for PGA absorption, suggesting the presence of another cause.

**Intravascular device and metal allergy**

The incidence of skin complications associated with metal implants used in various treatments is about 5% and these are associated with T-cell-mediated type IV allergic reaction.

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*Fig. 3* Dynamic perimetry. Right eye-dominant right homonymous visual field defect was observed.
Regarding comparative study on the association between the patch test and intravascular devices, no study on coil embolization of cerebral aneurysm has been reported, but in-stent restenosis (ISR) of the coronary artery has been reported. Norgaz et al.\textsuperscript{10} reported that they performed a preoperative nickel patch test in 43 consecutive patients undergoing coronary artery stent placement and ISR occurred in one of three patch test-positive and 15 of 40 patch test-negative patients, concluding that there was no association between the patch test and ISR. Iijima et al.\textsuperscript{15} performed a patch test in 109 patients who received the first coronary artery stenting and 65 patients who developed ISR and observed that restenosis after the first treatment was not associated with the patch test, but the incidence of recurrent restenosis after re-dilatation for treatment of ISR was significantly higher in patch test-positive patients ($p=0.02$), and the patch test was a significant factor of recurrent restenosis on multivariate analysis ($p=0.02$). Aliağaoğlu et al.\textsuperscript{16} retrospectively performed a nickel patch test in 31 patients with ISR and 30 patients without ISR and observed that seven patients were patch test-positive and all were ISR patients ($p<0.006$). Direct comparison is difficult because the study design was different, and no conclusion may have been reached with regard to the association between the patch test and intravascular devices. Regarding the cause of metal allergy-induced ISR, excess fiber growth and inflammatory reaction in the stent or vascular wall beyond the range are considered factors.\textsuperscript{17} The present patient was patch test-positive and the range of stenosis exceeded the region with the device.

As described above, multiple rare pathologies, which do not normally occur, appeared simultaneously, very severe stenosis was formed in the region beyond the device placement range in the aneurysm neck without coil migration into the parent artery, a severe treatment-resistant influence was observed in a period different from the period reported to be with reactions to the surrounding tissue after coil embolization, positive reactions to patch tests of metals contained in the coil used, an increase in eosinophils, and its reduction after treatment were observed, and the stenosis lesion and edematous change were improved by steroid, suggesting that the pathology of this case was not the only normal tissue reaction after treatment, and allergic excess inflammatory reactions were also involved, which may have resulted in wall thickening induced by thrombosing and inflammatory reactions even in the chronic phase and slow progression of intimal formation.

In coronary artery stenting, therapeutic strategy is not decided based on preoperative metal patch tests,\textsuperscript{5} and preoperative patch test is not recommended because many cases are negative or false negative. The pathology of the present case in coil embolization of aneurysm has also been rarely reported and preoperative judgment is difficult unless the patient has a clear past medical history, but when excess change occurred around coils, not only excess reactions of the aneurysm healing process but also allergic foreign body reaction should be considered, and immediate examinations and additional drug administration may be necessary.

\section*{Conclusion}

We reported a patient who developed severe parent artery stenosis and edematous change around the aneurysm causing visual field defect in the chronic phase after coil embolization of aneurysm and allergic reactions were suspected as the cause. Although the pathology is rare and difficult to assume before treatment, it should be noted as a postoperative pathology.

\section*{Disclosure Statement}

None of the first and co-authors have a conflict of interest.

\section*{References}


