Intracranial Internal Carotid Artery Stenosis with Vulnerable Plaques Successfully Treated by Stenting under Cerebral Protection

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A short title: Cerebral protection during intracranial stenting

Abstract

Percutaneous transluminal angioplasty (PTA) with stenting for intracranial atherosclerotic lesions is usually performed without any protection devices. We report a unique case of atherothrombotic stenosis with the vulnerable plaque in the cavernous portion of the internal carotid artery (ICA), which was successfully treated by PTA/stenting under cerebral protection with the flow reversal system resulting in the retrieval of much amount of atherothrombolic debris, consistent with the high-resolution magnetic resonance imaging (HR-MRI) findings.

A 68-year-old woman presented repetitive transient ischemic attacks in the right ICA territory. Cerebral angiography revealed 80% stenosis in the cavernous portion of the right ICA. HR-MRI demonstrated lipid-rich plaques at this lesion. PTA/stenting was performed with a proximal protection device under flow reversal. Atherothrombotic debris obtained in the filter device contained lipid-rich macrophages and leukocytes; the particles measured from 100 to 550μm in size. Postoperative course was uneventful, and her symptoms completely disappeared.

Some selected cases of intracranial atherothrombotic ICA stenosis may need the endovascular treatment with cerebral protection system. HR-MRI is quite useful to evaluate such plaque characteristics even in the cavernous portion of the ICA.

Keywords: intracranial internal carotid artery; stenosis; stenting; cerebral protection; flow reversal system; high-resolution magnetic resonance imaging; debris; vulnerable plaque.

1. Introduction

Symptomatic intracranial atherosclerotic lesion is responsible for a significant part of ischemic strokes [1-4]. In the recent Warfarin-Aspirin Symptomatic Intracranial Disease (WASID) study, the two-year occurrence rates of ischemic stroke were 19.7% in the aspirin group and 17.2% in the warfarin group [1]. The GESICA study also reported that the 2-year recurrence rate of ischemic events in the territory of the stenotic artery was 38.2% despite best medical treatments [3]. The endovascular treatment is considered as a option of the treatments for such intracranial stenotic lesions refractory to the medical treatments [5-7]. For the endovascular treatment of the intracranial lesions, a distal protection device is not fully available at present. Recent reports demonstrated the occurrence of significant embolic complications during percutaneous transluminal angioplasty (PTA)/stenting for intracranial stenotic lesions [6, 8-11].

We herein present a unique case of the cavernous portion ICA stenosis with vulnerable plaques demonstrated on high-resolution magnetic resonance imaging (HR-MRI), which was successfully treated by PTA/stenting under the flow reversal system resulting in the retrieval of much amount of atherothrombolic debris, consistent with the HR-MRI findings. Clinical implications of this case for such intracranial atherothrombotic lesions are discussed.

2. Case Report

A 68-year-old woman presented transient weakness of the left extremities. MRI demonstrated small infarcts in the bilateral deep white matter, and MR angiography (MRA) suspected right intracranial ICA stenosis. She was admitted to our hospital because of repetitive transient ischemic attacks despite 4-month oral intake of aspirin (100mg daily) and statin. Diabetes mellitus and hypertension were medically controlled for 8 years. Cerebral angiography revealed 80% stenosis in the cavernous portion of the right ICA (Fig. 1A). The right anterior cerebral arterial territory was supplied by collateral flow through the anterior communicating artery. There was no discernible right posterior communicating artery. The right cervical ICA was intact. HR-MRI (1.5-T, Signa CV/I; General Electronic Medical Systems, Milwaukee, WI) demonstrated that the plaque in the cavernous portion of the right ICA was hyperintense both on the T1-weighted imaging (T1WI) and proton density-weighted imaging (PDWI), and slightly hyperintense on 3D time-of-flight MRA imaging (Fig. 2A-C). Moreover, the plaque was partially enhanced with gadolinium (Fig. 2D). The parameters for the MRI sequences were as follows: (1) T1WI: 2D FSE, TR/TE 617/11 ms, ETL=3; (2) PDWI: FSE, black-blood (double-inversion recovery) technique, TR = 2 heart beats (2069 ms, depending on heart rate), TE = 20 ms, ETL=16; and (3) 3D TOF: TR/TE 33/3.5 ms, the flip angle=20°, field-of-view=13 cm, matrix size=256 × 128 using a zero-fill interporation technique, slice thickness was 1.4 mm. Contrast-enhanced T1WI was obtained as a few minutes after injection of 0.2 ml (0.1 mmol)/kg of gadolinium contrast agent (Magnevist, Shering AG, Germany). Fat suppression was used for T1WI and PDWI. The in-plane resolution was 0.5 mm. These results suggested that the lesion was mainly composed of lipid-rich plaques [12, 13]. Based on the HR-MRI findings, we planned PTA/stenting under cerebral protection system to avoid distal emboli. ~~She~~ The patient was given antiplatelet agents (aspirin 200mg daily, ticlopidine 300mg daily) one week before the procedure. A Parodi antiembolic catheter (10.5F, ArteriA Medical Science, San Francisco, CA) [14] was introduced from the right femoral artery into the cervical portion of the right ICA, and a venous sheath was place in the left femoral vein. An external arteriovenous shunt was established through the side port of the Parodi balloon catheter under proximal occlusion of the right ICA so that debris-containing blood could be drained through a filter device (P-J shunt circuit; Ube Junken, Tokyo) to the left femoral vein. PTA was performed on the cavernous portion of the right ICA with a 4.0 x 12-mm balloon catheter (Gateway PTA balloon; Boston Scientific, Natick, MA), and a 4.0 x 15-mm stent (Driver; Medtronic, Minneapolis, MN) was successfully placed across the lesion. The stenotic lesion was dilated completely (Fig. 1B). Aspirin (200mg daily) and ticlopidine (300mg daily) were given one month after the procedure. Postoperative course was uneventful, and her symptoms disappeared completely. Diffusion-weighted imaging (DWI) performed after the procedure did not demonstrate any ischemic lesions.

Much amount of atherothrombotic debris was found in the filter device (Fig. 3A). That was primarily composed of acellular and amorphous materials containing lipid-rich macrophages and leukocytes in hematoxylin-eosin staining (Fig. 3B) [15]; the particles measured from 100 to 550μm in size. Characteristics of the debris were similar to those from the cervical carotid lesions [15].

3. Discussion

PTA/stenting is now becoming widespread for some selected intracranial atherosclerotic lesions refractory to best medical treatments [5-7], although cerebral protection systems have not been fully employed. PTA with balloon-mounted coronary stents has been associated with a high incidence of periprocedural complications [8, 9, 11]. In the SSYLVIA trial evaluating the NEUROLINK System (Guidant Corporation), the balloon-mounted cerebral stent for treatment of vertebral or intracranial artery stenosis [6], stroke occurred in 6.6% of patients within 30 days. On the other hand, PTA/stenting with the self-expanding stent has recently been performed with 6.1% of major periprocedural morbidity and mortality [7], while procedure-related lesions accounted 34.2% on MRI. Tsumoto et al [10] also reported that high signal spots on the DWI, indicating distal emboli, were observed in 70% of the cases with intracranial ICA stenosis following PTA/stenting without any protection systems. However, only a few reports recommended the use of protection systems during the treatment of such lesions. Touho et al [16] reported successful cases of intracranial ICA stenosis treated by PTA under proximal ICA occlusion, in which potential atherosclerotic particles or clots were aspirated through an occlusion balloon catheter. The present case is unique in successfully performing PTA/stenting for intracranial ICA stenosis under the flow reversal system. Imai et al [17] and Komiyama et al [18] reported similar case to ours with total occlusion of the intracranial ICA. The protection system used in the present case may, however, be limitedly applied for the treatment of ICA stenosis proximal to the C3 segment, because an anastomotic flow is still present via the ophthalmic artery [10].

In the present study, we collected a significant number of debris particles using a filter device, which were large enough, from 100 to 550μm in diameter, to cause significant cerebral infarction [19]. To date, the literatures have not precisely described

HR-MRI findings for such intracranial atherothrombotic plaques. Application of intracranial HR-MRI may be limited because of considerable distance between the skin surface and the intracranial arteries. In addition, the spatial resolution needs to be optimized to image the small size of intracranial arteries [20]. According to the previous reports, the lipid-rich necrotic core of the carotid plaques shows a hyper signal intensity on the T1WI and the PDWI without significant enhancement [12, 13, 21, 22]. In our case, HR-MRI demonstrated similar results suggesting intracranial lipid-rich plaques. We therefore performed the endovascular treatment using the flow reversal system. Indeed, we obtained a significant size of atherothrombotic debris containing lipid-rich macrophages and leukocytes, which was consistent with the HR-MRI findings.

In the present case, we performed PTA at fast to allow the balloon-mounted coronary stent to easily pass the stenotic lesion. In Japan, cerebral stents for treatments of intracranial atherosclerotic stenosis now cannot be acquired, and the balloon-mounted coronary stents are converted only when written informed consent <u>is</u> obtained from the patient.

4. Conclusion

We reported a case of the cavernous portion ICA stenosis successfully treated by PTA/stenting under cerebral protection with the retrieval of much amount of atherothrombolic debris, which was consistent with the HR-MRI findings. We believe that some selected cases of intracranial ICA stenosis need the endovascular treatment with cerebral protection system.

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Figure Legends

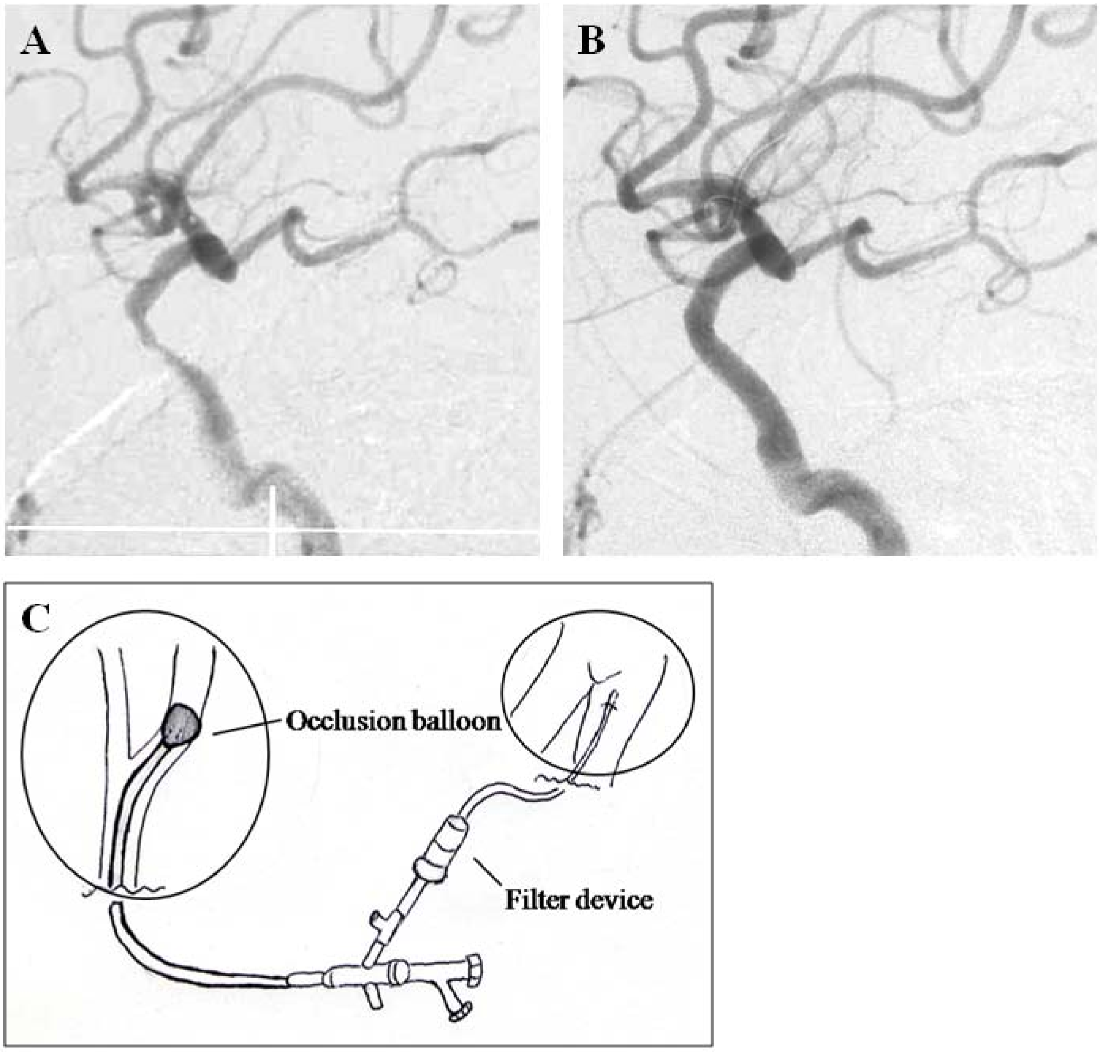

Figure 1: Lateral view of the right internal carotid artery (ICA) angiogram (A) showing 80% stenosis in the cavernous portion of the right ICA. A postprocedural angiogram (B) demonstrating a satisfactory widening of the lesion. The endovascular procedure is illustrated (C). PTA/stenting is performed under proximal balloon occlusion.

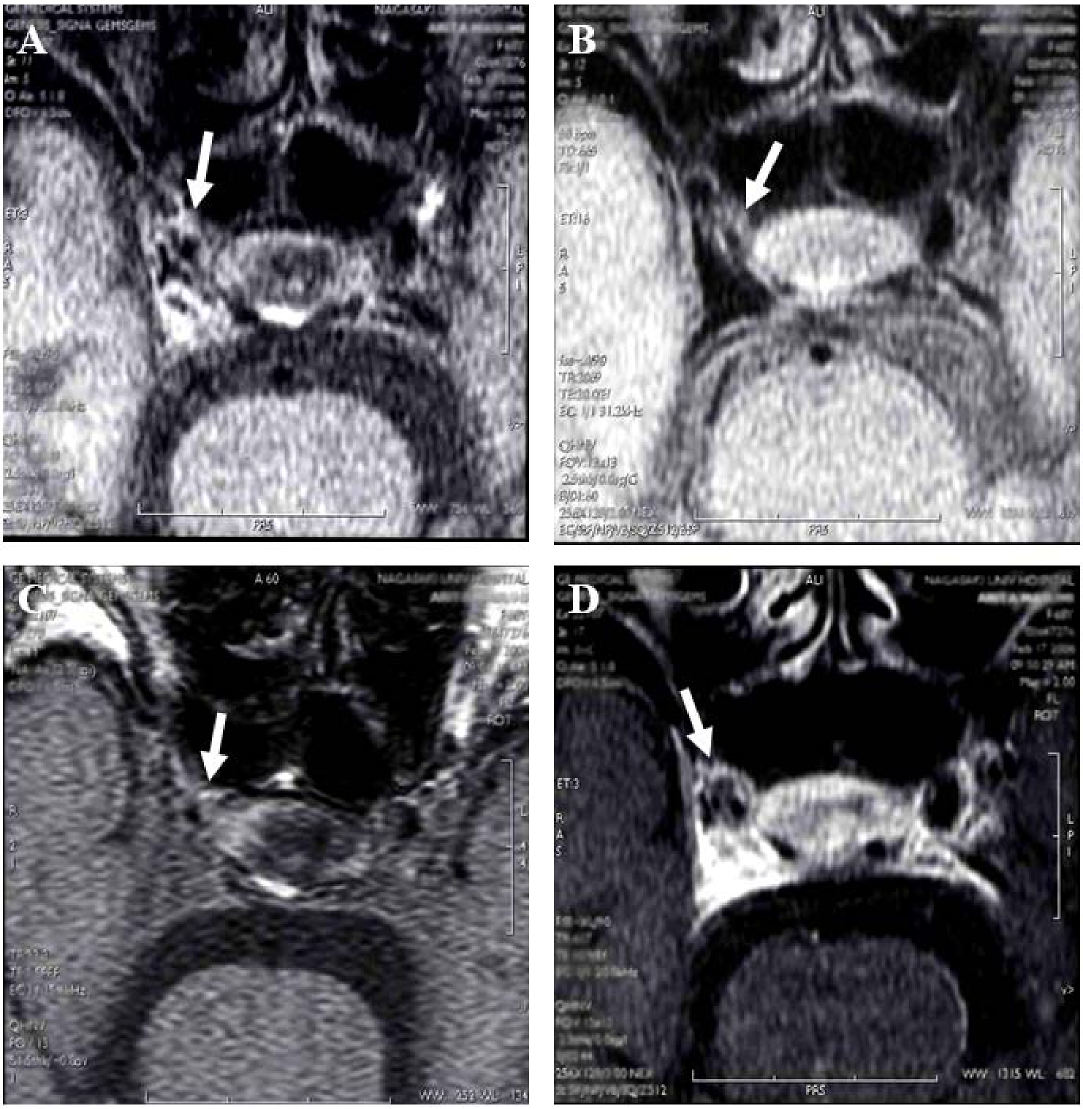

Figure 2: High-resolution magnetic resonance imaging demonstrating the right internal carotid artery plaque (white arrows) to be hyperintense on the T1-weighted imaging (A) and proton density-weighted imaging (B), and slightly hyperintense on 3D time-of-flight imaging (C).The plaque is partially enhanced with gadolinium (D).

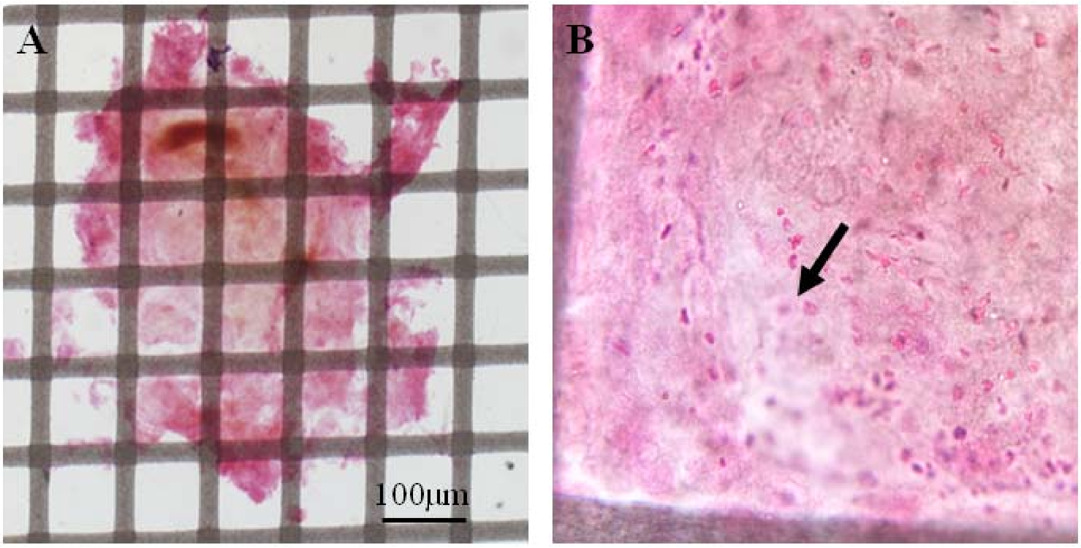

Figure 3: Hematoxylin-eosin staining showing the debris. The largest size of debris (shown in this figure) measures 550×450μm (A). The debris is primarily composed of acellular and amorphous materials containing lipid-rich macrophages (black arrow) and leukocytes (B).