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Case Report

Successful Obliteration of Unclippable Large and Giant Middle Cerebral Artery Aneurysms Following Extracranial-Intracranial Bypass and Distal Clip Application

Won Ki Yoon, M.D.,[1] Young Jin Jung, M.D.,[2] Jae Sung Ahn, M.D.,[2] Byung Duk Kwun, M.D.[2]

Department of Neurosurgery,[1] St. Paul's Hospital, The Catholic University of Korea College of Medicine, Seoul, Korea
Department of Neurological Surgery,[2] Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Large to giant middle cerebral artery aneurysm is a challenging disease, especially when incorporating important perforating arteries. Surgical risk increases by perforator infarction and anatomical complexity. In this clinical setting, extensive consideration of surgical options is needed. The two cases described here were unruptured and had rather stable wall. Because of their large and giant size, hardness and incorporated arteries, it was not affordable to isolate them by means of clipping or trapping. The procedure as the alternative to conventional treatment modalities, extracranial-intracranial bypass followed by clipping of only the efferent artery successfully treated the aneurysms.

KEY WORDS : Aneurysm · Bypass · Clip · Middle cerebral artery.

INTRODUCTION

Treatment of giant middle cerebral artery (MCA) aneurysms is a challenging task for neurovascular surgeons, especially aneurysms in the fusiform configuration. The large size of such aneurysms hinders access to the neck and parent vessel for proximal control and makes it difficult to visualize the perforating vessels or large branches from the aneurysm. For these reasons, traditional treatment methods such as direct clipping, aneurysm thrombectomy with clip reconstruction, Hunterian proximal ligation, or surgical trapping with or without cerebral revascularization have limited roles and sometimes result in incomplete treatment with high perioperative morbidity or mortality[1,2,7,11]. The promising outcomes achieved by endovascular surgery for small aneurysms remain unconfirmed for giant aneurysms, especially fusiform aneurysms[4,5,12]. The present report describes two MCA aneurysm cases, one a giant fusiform and the other a large saccular aneurysm with a broad neck. Treatment involved superficial temporal artery (STA)-MCA bypass followed by clip application just distal to the aneurysm. We discuss the rationale of this technique as an alternative treatment strategy for large to giant aneurysms not suitable for conventional treatment.

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• Address for reprints : Jae Sung Ahn, M.D.
Department of Neurological Surgery, Asan Medical Center, University of Ulsan College of Medicine, 86 Asanbyeongwon-gil, Songpa-gu, Seoul 138-736, Korea
Tel : +82-2-3010-3550, Fax : +82-2-476-6738
E-mail : jsahn@amc.seoul.kr

CASE REPORT

Case 1

A 47-year-old female was admitted complaining of severe intractable headache. Brain computed tomography (CT) and CT angiography revealed an unruptured and partially thrombosed giant fusiform aneurysm in the left MCA, and a small infarction on the insular cortex around the aneurysm (Fig. 1A). Three-dimensional rotational digital subtraction cerebral angiography (DSA) showed the aneurysm extended from the mid M1 to the proximal portion of the M2 branches (Fig. 1B).

Dissection of STA for bypass and a large fronto-temporal craniotomy was carried out. The aneurysm was fusiform and

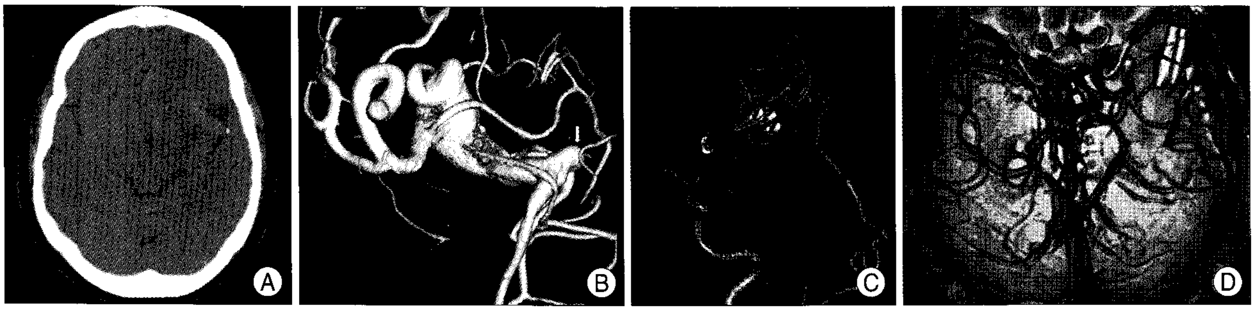

Fig. 1. A : Non-contrast enhanced brain CT. There is a thrombosed giant aneurysm in left sylvian fissure. Note low density in left basal ganglia, representing perforator infarction. B : Three-dimensional rotational cerebral angiographic image with anteroinferior angled view. A partially thrombosed giant fusiform aneurysm is located from mid M1 to proximal M2. Several arteries are branching from the aneurysm. There is a small saccular protrusion of the aneurysm at the M1 bifurcation site (arrow). The beak-like stump is revealed as an occluded M1 branch during operation (asterisk). C : Three-dimensional rotational angiography on postoperative Day-8 shows good patency of the bypass graft with fluent distal flushing. The aneurysm can no longer be seen. Note the residual proximal stump of the aneurysm. D : CT angiography at 12 months postoperatively shows that the aneurysm remains completely excluded from the circulation and that perfusion of the left MCA territory appear to be normal (i.e., comparable to the right side).

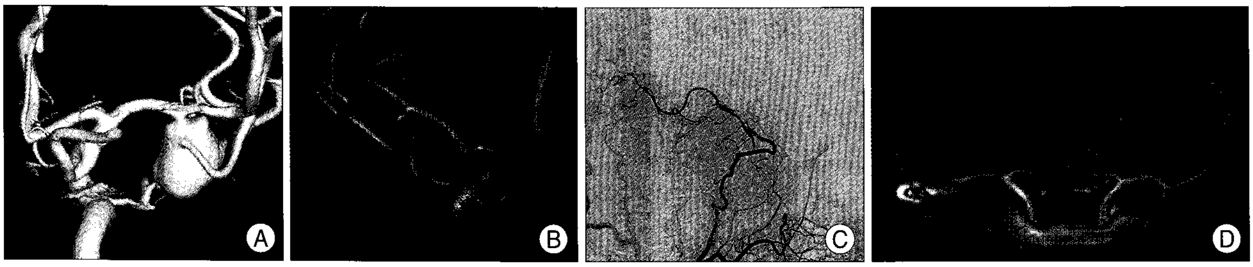

Fig. 2. A : Three-dimensional rotational cerebral angiography with posteriosuperior angled view shows a large saccular aneurysm on the inferior branch of left M1. It is located at the non-branching site of the artery, which is engulfed by the aneurysm. B : Postoperative three-dimensional rotational angiography of left internal cerebral artery shows complete obliteration of the aneurysm with spontaneous thrombosis following single clip application on the efferent MCA. The parent arterial origin is still visible even after complete exclusion of the aneurysm from blood flow. C : Selective external carotid angiography demonstrates good patency of the bypass graft. D : Follow-up CT angiography six months after treatment. It shows same findings as B; total occlusion of the aneurysm, stump of the proximal parent vessel.

involved multiple small branching arteries. And, it had severe atherosclerotic changes with partial calcification in the wall. Its length was over 42 mm without a definitive neck. The branching artery with a beak-like end in the angiography was revealed to be a blind stump without any blood flow according to microvascular Doppler ultrasonography. An end-to-side anastomosis between the M3 branch and the STA was performed. After the bypass, multiple clips were applied to the distal end of the aneurysm to maintain high flow through the bypass. Immediately after clipping, we observed complete cessation of blood flow within the aneurysm, decrease of the aneurysm size and good bypass graft patency. Blood flow was detected only at the proximal M1 portion near the aneurysm, and therefore proximal occlusion for trapping of the aneurysm was postponed to a later operation, if necessary, because we could not inspect all branches around the aneurysm.

Follow-up DSA performed on postoperative Day-8 revealed near complete non-opacification of the aneurysm with small residual proximal stump and fluent flow through the bypass to the distal MCA territory (Fig. 1C). The patient was discharged without any neurological deficits. Daily 100 mg of aspirin was maintained for three months postoperatively to prevent thromboembolic complications. CT angiography and clinical follow-up at postoperative 12 months revealed the same results (Fig. 1D).

Case 2

A 56-year-old female presented complaining of chronic severe headache. Workups revealed a partially thrombosed saccular unruptured aneurysm with dome height of 15 mm and neck width of 5 mm at the non-branching site of the inferior division of right MCA. The aneurysm neck was engulfing its parent artery (Fig. 2A). During surgery it was clear that the aneurysm wall was too hard to clip without risk of occlusion of the distal parent artery or incomplete treatment. Therefore, an end-to-side anastomosis between the M2 segment distal to the aneurysm and the STA was performed and a clip was applied to the efferent artery arising from the aneurysm to maintain high flow through the bypass. At this time, blood flow within the aneurysm was completely stopped. We tried to place a proximal clip at the origin of the parent artery branching from M1 trunk. However, the space between the M1 trunk and the aneurysm was too narrow, and the clip slipped and impinged on the M1, resulting in severe M1 narrowing. Therefore, we abandoned further attempts at proximal clipping knowing that endovascular occlusion could be performed at a later stage if necessary. DSA performed on postoperative Day-7 showed complete nonvisualization of the aneurysm except the M1 branching artery origin stump, and good flow through the graft to the MCA territory (Fig. 2B, C). The postopera-tive course was uneventful and the patient was discharged without any neurological problems. Daily 100 mg of aspirin was maintained for three months postoperatively to prevent thromboembolic complications. Radiological and clinical follow-up six months later showed still complete obliteration of the aneurysm and normal neurological status (Fig. 2D).

DISCUSSION

Spontaneous intra-aneurysmal thrombosis after bypass procedures with or without parent vessel occlusion has been reported[3,6,8-10,13,15]. Reduction of blood flow through the aneurysm to the efferent artery and subsequent spontaneous thrombosis of the aneurysm can be induced by changing intra-aneurysmal hemodynamics. While good radiological and clinical outcomes can be achieved using extracranial-intracranial (EC-IC) bypass only[6,9], the fates of both the bypass graft and the aneurysm are not predictable. It is important to maintain sufficient flow through the bypass to keep the bypass patent. Without occlusion of flow from the main artery, the flow can collide at the anastomosis and the bypass can be occluded[3]. Therefore, maintaining good patency of the graft requires obstruction of blood flow to the efferent artery through the aneurysm. And, if blood flow to the aneurysm remains, the aneurysm can be unchanged or even grow in size, and have a high risk of rupture. Hence, aneurysm trapping is recommended for optimal long-term surgical results. However, large cortical branches or important perforating vessels arising from the aneurysm sac can contraindicate the use of trapping procedures, especially in giant aneurysms because it is impossible to inspect all the branches at every aspect of the aneurysms[1,2,11]. In such cases, proximal or distal occlusion can only be a safer method.

Giant fusiform aneurysms can be treated in a 1- or 2-stage procedure. In a 1-stage procedure, immediately following the STA-MCA bypass, the aneurysm can be excluded from the circulation via trapping. In a 2-stage procedure, the first stage consists of an EC-IC bypass procedure with only proximal or distal clipping of the aneurysm. After surgery, careful clinical and radiological follow-up is required to evaluate changes in aneurysm size, intramural thrombosis, clinical signs and symptoms related to branch occlusion, and bypass patency. The second stage can be performed on a later date if there is growth or no change in size. It involves proximal or distal occlusion using surgical or endovascular means. Endovascular coiling is an easier and safer method of occluding the remaining parent artery because there is less risk of injury to the bypass graft compared to surgical re-exploration[10,12,14].

Clipping of the efferent artery just distal to the aneurysm after the bypass was developed to avoid the risk of parent vessel trapping. At first glance, concern may exist that increased intra-aneurysmal pressure might lead to rupture. However, this approach has been shown to provide excellent clinical outcomes[3,8,10,13]. Horowitz et al.[8] explained that, due to the almost complete flow interruption within the aneurysm, the transitory increase in intraluminal pressure after distal clipping should be far lower than increases induced by physiological variations during daily activities, as demonstrated by Bernoulli's equation, and these changes should not be considered to increase the risk of rupture. Only with these pressure and hemodynamic aspects, it is insufficient to explain current results. Aneurysm wall thickness and its characteristics might play an important role. The present report described use of distal occlusion in unruptured cases only, and in these cases the aneurysm wall was rather thick, even hard, and stable. Even though there is a report of this technique successfully used[13], we would not have performed on ruptured aneurysm because of its instability of the wall. In such cases, we would have trapped the aneurysm despite the risk of damage to perforators arising from the aneurysm. Use of distal occlusion even in unruptured cases requires vigilant monitoring of intra-aneurysmal blood flow. We watched for the cessation of pulsatile movement of the aneurysm wall upon distal clipping, monitored aneurysm stability for some time during surgery, and performed repeated microvascular Doppler examination at varying depths to confirm complete cessation of intra-aneurysmal blood flow.

CONCLUSION

Large to giant sized MCA saccular and fusiform aneurysms with relatively stable walls were treated using STA-MCA bypass and clipping distal to the aneurysm. Treatment was successful without neurological sequelae. Also, their short-term follow-up demonstrated stable results. This technique might be an alternative strategy for intracranial large or giant unruptured aneurysms which are not suitable for direct clipping or where trapping carries a high surgical risk.

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