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

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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. The promising outcomes achieved by endovascular surgery for small aneurysms remain unconfirmed for giant aneurysms. 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.

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...
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 endo-
vascular 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[3,8,10,13,15]. Reduction of blood flow through the 
aneurysm to the efferent artery and subsequent spontaneous 
thrombosis of the aneurysm can be induced by changing 
intracranial hemodynamics. While good radiological 
and clinical outcomes can be achieved using extracranial-
intracranial (EC-IC) bypass only[6,9], the fates of both the by-
pass graft and the aneurysm are not predictable. It is impor-
tant 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[6]. 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 aneu-
rysms 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 per-
forating vessels arising from the aneurysm sac can contrain-
dicate the use of trapping procedures, especially in giant 
aneurysms because it is impossible to inspect all the branches 
at every aspect of the aneurysm[2,21]. 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 sym-
ptoms 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 oc-
clusion using surgical or endovascular means. Endovascular 
coiling is an easier and safer method of occluding the remain-
ing 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 
intraneurysmal pressure might lead to rupture. How-
ever, 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 aneu-
rysms, 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 ex-
plain current results. Aneurysm wall thickness and its char-
acteristics 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 tech-
tique successfully used[10], 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 clip-
ning or where trapping carries a high surgical risk.

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