Access this article online

Quick Response Code:

Website: http://www.braincirculation.org

DOI: 10.4103/bc.bc_58_20

Mechanical clot dissolution technique for surgical clip-related occlusions: An emergent triple-step approach

Chirag Jain, Neha Choudhary, Vikas Bhatia, Ajay Kumar

Abstract:

Cerebral ischemia following clipping of cerebral aneurysms constitutes major cause of morbidity and mortality. Clip-related injury to vessel, postoperative clip rotation, prolonged temporary occlusion, intraoperative rupture, and vasospasm are some etiological factors compromising forward flow in parent or branch vessel. On suspicion of compromised forward flow, immediate intraoperative evaluation is done to detect the cause of vascular compromise and further management is done by microsurgical or endovascular means. We describe a case of ruptured distal anterior cerebral artery (ACA) aneurysm complicated by occlusion of ACA after surgical clipping. The patient was managed by endovascular means by combined technique of intra-arterial nimodipine, antiplatelet infusion, and mechanical clot disruption using J-tip microwire.

Keywords:

Abciximab, aneurysm, angiography, nimodipine, thrombosis

Introduction

Iatrogenic vascular occlusion is one of the major complications during clipping of cerebral aneurysms, leading to development of postoperative infarction. Early recognition of vascular compromise is indispensible to prevent irreversible damage and fatal consequences. Intraoperative repositioning of the clip or institution of thrombolytic therapy is an initial approach. Herein, we report a case of clip-induced arterial occlusion managed with endovascular means. This case report uniquely highlights the staged technique which should be followed to achieve reperfusion in all such cases since the etiology of intraoperative occlusion is usually not known.

Case Report

A 42-year-old female with sudden-onset severe headache, dizziness, loss of consciousness, and multiple episodes of vomiting underwent noncontrast computed tomography (CT) which showed modified Fisher Grade 3 subarachnoid hemorrhage (SAH) in the anterior interhemispheric fissure [Figure 1a]. CT angiography [Figure 1b-d] confirmed an anteriorly directed saccular multilobulated aneurysm arising from left distal anterior cerebral artery (ACA) at A2 bifurcation measuring 3.5 mm × 3 mm (dome) and 1.5 mm (neck). The patient underwent emergency microsurgical management of the ruptured intracranial aneurysm. Two clips (6.3 mm curved tip and 3 mm straight tip) were placed at neck of aneurysm. Severe intraoperative vasospasm was seen. Intraoperative ICG angiography revealed compromised blood flow in the left A2 ACA. Clip repositioning was attempted; however, distal blood flow could not be re-established despite repeated attempts. Closure was done and the patient was shifted immediately to intervention suite for further management.

Department of Radiodiagnosis and Imaging, Post Graduate Institute of Medical Education and Research, Chandigarh, India

Address for correspondence:
Dr. Chirag Jain, 21, Aradhana, Sector-13, RK Puram, New Delhi - 110 066, India.
E-mail: chirag1803@gmail.com

Submission: 01-11-2020
Revised: 15-04-2021
Accepted: 18-05-2021
Published: 27-08-2021

How to cite this article: Jain C, Choudhary N, Bhatia V, Kumar A. Mechanical clot dissolution technique for surgical clip-related occlusions: An emergent triple-step approach. Brain Circ 2021;7:207-10.

Diagnostic angiogram showed nonopacification of left distal A2 ACA [Figure 2a,c] beyond surgical clips with perfusion deficit in the left ACA territory [Figure 2b, arrowheads]. The aneurysm was not visualized. There was severe diffuse vasospasm of arterial tree [Figure 3a]. A step-wise approach was used to revascularize the nonopacified vessel. After placement of guiding catheter in the left internal carotid artery, intra-arterial (IA) vasodilator (nimodipine) infusion with continuous pressured saline flush mixed with 3 mg nimodipine was given to relieve the vasospasm [Figure 3b]. Next, a microcatheter was negotiated in proximal A2 ACA followed by infusion of 8 mg of antiplatelet drug, abciximab at standard rate of 0.125 mcg/kg/min [Figure 3c]. Diagnostic run after antiplatelet infusion [Figure 3d] showed only mild forward flow of ACA beyond origin of orbitofrontal artery. At last, mechanical clot disruption was done with 0.014″ microguidewire after forming a reverse J tip [Figure 3e]. The wire was carefully and slowly advanced till A3 ACA [Figure 3f]. Postprocedure angiogram showed segmental irregularity of ACA with complete recanalization of the left ACA [Figures 2d, 2f, and 3g, 3h] and normal cerebral perfusion [Figure 2e]. The patient had neurological recovery over 48 h of the procedure; however, he eventually succumbed to sudden cardiac arrest.

Discussion

Iatrogenic vascular occlusion in open surgery is a significant predictor for poor prognosis. Park *et al*. showed that in 1954 cases of unruptured aneurysms treated with clipping, 0.6% of cases had compromised distal vascular flow and underwent clip repositioning.[1] Another study by Gupta *et al*. in ruptured anterior communicating artery (ACoA) aneurysms treated by clipping, showed that about one-fourth of total cases (29/118) developed postoperative infarcts.[2] The predictors for the development of cerebral infarction included a higher WFNS grade, history of seizures, or presence of neurological deficits at presentation, an intraoperative clip-related vascular injury, a prolonged temporary occlusion, intraoperative rupture, and clip rotation. Clip rotation is one of the significant causes of vascular injury. Kim and Seung reported three cases in which postoperative rotation of clip caused a compromise in blood flow.[3] When brain retractors are removed after clipping, the edematous brain parenchyma puts pressure on the clip which may cause change in its orientation and can cause impingement on adjacent branch or parent vessel which can further lead to thrombosis of vessel. Atherosclerotic changes at neck of the aneurysm may also cause slippage of the clip.[1] Prompt recognition of vascular compromise is important to prevent development of infarction. Intraoperative indocyanine green angiography, intraoperative Doppler study, motor evoked potential, and somatosensory evoked potential are important methods of monitoring distal flow intraoperatively. Clip-induced injury can be corrected by exploration and surgical repositioning. Previous studies have also used IA recombinant pro-urokinase for recanalization of thrombosed artery.[4] A bolus of heparin (typically 1000–5000 IU) or intraoperative direct placement of sponge impregnated with calcium channel blocker[5] on the vessel can also be attempted. At last,

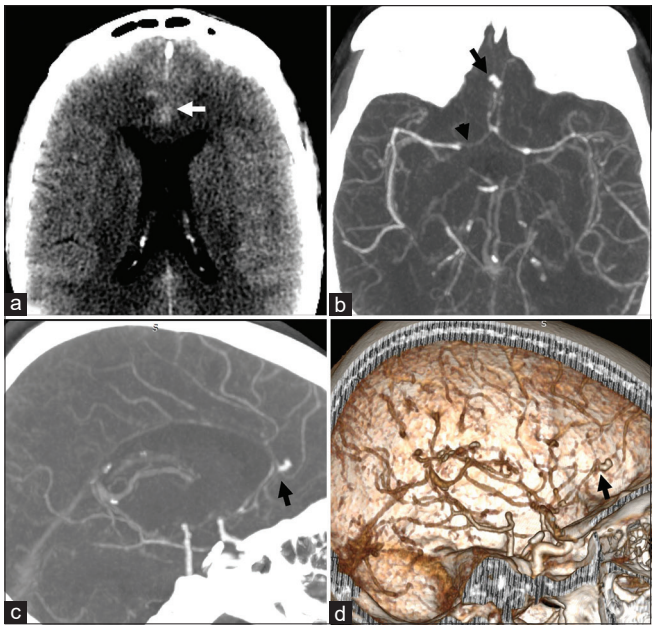

Figure 1: Computed tomography head: (a) Noncontrast computed tomography scan of head showing thick subarachnoid hemorrhage in the anterior interhemispheric fissure (arrow). Diffuse severe vasospasm is seen in the (arrowhead, b) with anteriorly directed aneurysm at A2 anterior cerebral artery bifurcation (arrow, a and c). VR image (d) showing the lobulated morphology of the anteriorly directed aneurysm with severe vasospasm

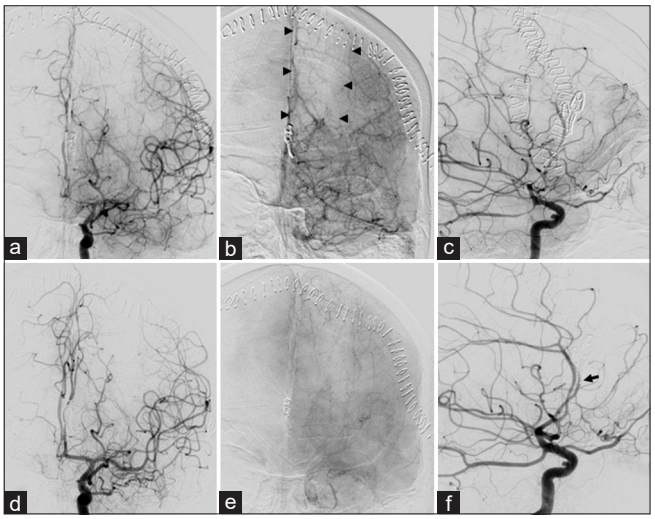

Figure 2: (Digital subtraction angiography): Left internal carotid artery angiogram shows non opacification of left A2 anterior cerebral artery in anterioposterior (a) and lateral (c) projections with perfusion deficit in left anterior cerebral artery territory (b, arrowheads). Postprocedure angiogram shows normal opacification of distal anterior cerebral artery in anterioposterior (d) and lateral (f, arrow) projections with restoration of perfusion deficit (e) in left anterior cerebral artery territory

direct mechanical dissolution of clots, albeit risky, can also be performed as a last resort. Endovascular techniques are often sort for surgically refractory arterial occlusions.

Besides, the presence of an *in vivo* thrombus, vasospasm, and vascular dissection can be other contributing causes for intraoperatively diagnosed vascular occlusion. In this report, we performed a step-wise technique to handle all three etiologic factors for successful revascularization in these scenarios. Directly taking a stent-retriever to re-establish flow in a surgically occluded "fragile" vessel can lead to disastrous consequences. The importance of each step cannot be undermined and facilitates the performance of the next step. The *first step* is to relieve SAH-induced vasospasm (defined by reduction of arterial diameter by more than 50%) by instillation of an intra-arterial vasodilator. Nimodipine is a voltage-gated calcium channel antagonist inhibiting the entry of calcium into smooth muscle cells of arteries with resultant vasodilatation. Apart from vasodilatation, nimodipine has neuroprotective effects, improves oxygen metabolism, and helps in prevention of free radical injury and apoptosis.[6] The dose of IA nimodipine used is 1–3 mg (depending on the severity of vasospasm) diluted to 25% using physiologic saline. The infusion is continued over 10–30 min at the rate of 2 ml/min.[6] The advantage of IA nimodipine is to relieve vasospasm, to improve clinical outcomes in patients, as well as to help in negotiation of microcatheter to site of occlusion.

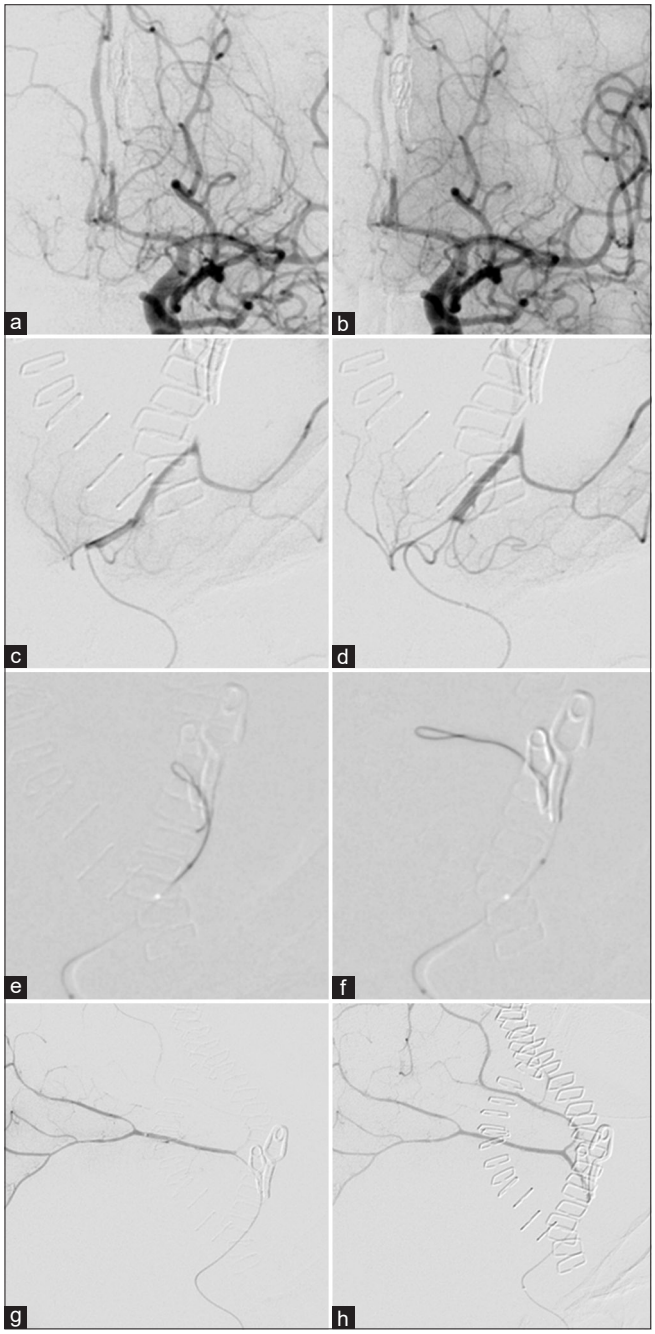

Figure 3: (Step-wise): (1) Intra-arterial vasodilator (nimodipine) therapy for relief of vasospasm (a, prevasodilation; b, postvasodilation) for negotiation of microcatheter. (2) Intra-arterial antiplatelet (abciximab) infusion showing mild resolution of thrombus at origin of orbitofrontal artery (d) as compared to (c). (3) J tip microwire manipulation across occlusion (e and f). Postprocedure microcatheter runs (g and h) showing complete resolution

The *second step* is addition of an antiplatelet agent by continuous slow infusion. Acute thrombus formation is platelet rich, and thus, glycoprotein IIa/IIIb receptors antagonist, abciximab, successfully used in lysis of iatrogenic platelet-rich thrombosis in endovascular procedures.[7] Abciximab is Fab fragment of chimeric human-murine monoclonal antibody directed against GpIIb-IIIa receptors and is given at a dose of 4–10 mg, diluted to 0.2 mg/ml using physiologic saline, and is infused over 10–20 min. Eptifibatide and tirofiban are other alternative GP IIa/IIIb antagonists. Meta-analysis has shown that abciximab is associated with lower rates of short- and long-term morbidity when compared with fibrinolytics with a trend toward higher recanalization rates.[8] Addition of an antiplatelet to the procedure may completely dissolve the clot or at least make it softer before microwire manipulation is performed.

Finally, in the *third step*, a J tip microguidewire is used to revascularize the ischemic territory. Platelet-rich thrombi contain higher amounts of plasminogen activator inhibitor 1 and therefore are little resistant to thrombolysis as compared to red blood cell-rich clots.[9] Mechanical clot disruption can be achieved by microguidewire with J tip. Straight tip microguidewire can cause iatrogenic dissection and vessel perforation; therefore, the tip of the wire is shaped to a "J" which is atraumatic. Further, the cause of the occlusion is often not known after surgical clipping. It may be due to vascular dissection or arterial thrombus. Negotiating the J tip wire carefully and slowly is an important final step that commences mechanical clot disruption and improves the

action of antiplatelet drug by allowing seepage of drug within the interstices of the thrombus.[10]

By combining above three sequential steps, revascularization of iatrogenically occluded vessel can usually be achieved. A stent retriever or aspiration catheter may be employed only in refractory cases, bearing in mind the fragility of surgically handled vessel. Although clip-induced thrombosis of parent or branch vessel is not a very rare complication, till now, there is no literature available on its endovascular management in our knowledge. Endovascular management should be considered to be a reliable management option, when intraoperative microsurgical management fails to achieve revascularization, as prompt and early action improves the chances of recanalization by preventing development of core infarct in involved territory.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Park W, Ahn JS, Lee SH, Park JC, Kwun BD. Results of re-exploration because of compromised distal blood flow after clipping unruptured intracranial aneurysms. Acta Neurochir (Wien) 2015;157:1015-24.
2. Gupta A, Tripathi M, Umredkar AA, Chauhan RB, Gupta V, Gupta SK. Impact of postoperative infarcts in determining outcome after clipping of anterior communicating artery aneurysms. Neurol India 2020;68:132-40.
3. Kim JW, Seung WB. Delayed branching artery occlusion caused by clip rotation after intracranial aneurysm clippings. Case Rep Neurol 2018;10:159-64.
4. Eliava S, Pilipenko Y, Shekhtman O, Konovalov A. Reversal of intraoperative arterial thrombosis with a fibrinolytic agent when treating large and giant partially thrombosed aneurysms of the middle cerebral artery. J Neurosurg 2016;124:1114-22.
5. Kasuya H, Onda H, Sasahara A, Takeshita M, Hori T. Application of nicardipine prolonged-release implants: Analysis of 97 consecutive patients with acute subarachnoid hemorrhage. Neurosurgery 2005;56:895-902.
6. Baggott CD, Aagaard-Kienitz B. Cerebral vasospam. Neurosurg Clin N Am 2014;25:497-528.
7. Mounayer C, Piotin M, Baldi S, Spelle L, Moret J. Intraarterial administration of Abciximab for thromboembolic events occurring during aneurysm coil placement. AJNR Am J Neuroradiol 2003;24:2039-43.
8. Brinjikji W, Morales-Valero SF, Murad MH, Cloft HJ, Kallmes DF. Rescue treatment of thromboembolic complications during endovascular treatment of cerebral aneurysms: A meta-analysis. AJNR Am J Neuroradiol 2015;36:121-5.
9. Schumacher HC, Gupta R, Higashida RT, Meyers PM. Advances in revascularization for acute ischemic stroke treatment. Expert Rev Neurother 2005;5:189-201.
10. Sorimachi T, Fujii Y, Tsuchiya N, Nashimoto T, Harada A, Ito Y, *et al.* Recanalization by mechanical embolus disruption during intra-arterial thrombolysis in the carotid territory. AJNR Am J Neuroradiol 2004;25:1391-402.