Clinical Case Report

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Treatment of giant cavernous aneurysm in an elderly patient via extracranial–intracranial saphenous vein bypass graft in a hybrid operating room

A case report

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Abstract

Rationale: Extracranial–intracranial saphenous vein bypass (EC-IC SVB) remains indispensable for treating giant cavernous aneurysms. We report an unusual case of a giant cavernous aneurysm in an elderly patient treated with EC-IC SVB in a hybrid operating room. Immediately following proximal ligation of the internal carotid artery (ICA), she suffered an acute intraoperative encephalocele.

Patient concerns: A 71-year-old woman had suffered from severe headache and double vision for 4 months.

Diagnoses: The woman was diagnosed with a right giant cavernous aneurysm.

Interventions: She was treated with an EC-IC SVB with therapeutic ICA occlusion in the first biplane hybrid operating room in China. Just after proximal ligation of the ICA, she developed an acute encephalocele, and immediately underwent decompressive craniectomy. During the surgery she underwent 3 angiographic explorations.

Outcomes: After surgery, the aneurysm disappeared, and the graft was patent. Postoperative computed tomography and computed tomography angiography indicated a cranial defect and graft patency.

Lessons: Although a hybrid operating room could improve the patency of grafts, the timing of ICA ligation for giant cavernous aneurysm via EC-IC bypass deserves further discussion. Second-stage ICA occlusion could offer an alternative for elderly patients requiring such treatment. In addition, cranial flap removal could prevent further neurologic deficits in a case of acute intraoperative encephalocele.

Abbreviations: DSA = digital subtraction angiography, EC-IC = extracranial-intracranial, ICA= internal carotid artery, SV= saphenous vein, SVB = saphenous vein bypass.

Keywords: aneurysm, EC-IC bypass, elderly, hybrid operating room, ICA internal carotid artery

1. Introduction

It is well recognized that extracranial–intracranial (EC-IC) high-flow bypass (HFB) with therapeutic internal carotid artery (ICA) occlusion has become a treatment option for giant ICA aneurysms.[1,2] Intraoperative angiography thus continues to be an effective tool in the surgical treatment of brain vascular abnormalities, including complex aneurysms.[3] EC-IC high-flow bypass should be performed in a hybrid operating room to maintain procedural safety and efficacy. High-flow saphenous veins contribute to restoring adequate collateral flow in a patient suffering from insufficient cerebrovascular reserve or preserving cerebrovascular reserve in a young patient with long life expectancy.[1] The effectiveness of EC-IC saphenous vein bypass (SVB) in elderly patients, however, is still not clear. In addition, the best timing for ICA ligation for a giant cavernous aneurysm with EC-IC bypass has not been established. We report an unusual case of a giant cavernous aneurysm in an elderly patient treated via EC-IC HFB who suffered acute intraoperative encephalocele just after proximal ligation of the ICA in the first biplane hybrid operating room established in China.

2. Case presentation

A 71-year-old woman presented with a 4-month history of headache that had worsened during the past 2 weeks. She was normally developed, and her mind was clear. Her pupils were

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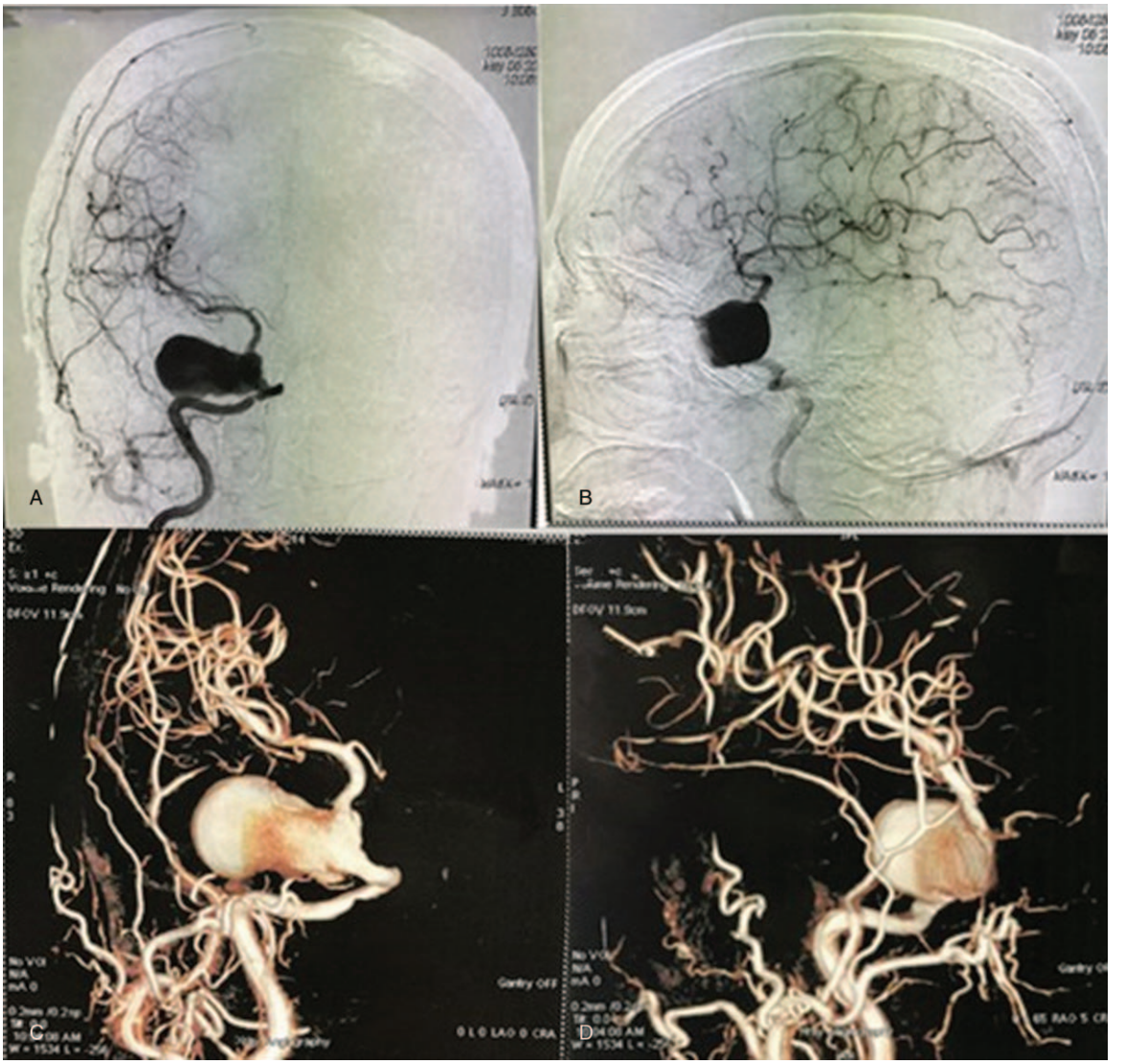

Figure 1. Digital subtraction angiography (DSA) from the previous hospital. (A and B) DSA shows a right internal carotid artery cavernous giant aneurysm. (C and D) 3-dimensional DSA displays the relationship between the aneurysm and surrounding vessels. DSA = digital subtraction angiography.

unequal, however, and the pupillary reaction of the right eye to light was absent and associated with double vision. Her neck was soft and supple. No other positive signs were found.

Digital subtraction angiography (DSA) showed a giant aneurysm in the cavernous portion of the right ICA (Fig. 1). A 20-min balloon occlusion test (BOT) was performed to check tolerance against right ICA permanent occlusion. Left hemiparesis appeared, indicating intolerance. We thus planned to perform EC-IC high-flow bypass using the saphenous vein with therapeutic ICA occlusion in our hybrid operating room (UNIQ FD2020 Hybrid-OR, Philips, The Netherlands).

The patient was put under general anesthesia via a 6-F sheath inserted into the right femoral artery. An external carotid artery–saphenous vein graft–middle cerebral artery (M2) bypass was performed in an end-to-side pattern followed by intraoperative DSA, which confirmed the patency of the graft. The aneurysm was also visualized using DSA (Fig. 2A and B). To adapt to hemodynamic changes, we decided to partly ligate the ICA, narrowing it with sutures. Intraoperative DSA showed that the ICA had narrowed, and the aneurysm became smaller (Fig. 2C) but was not eliminated. Therefore, the ICA was ligated immediately, followed by a third round of intraoperative DSA, which indicated that the graft was patent and the aneurysm had almost disappeared (Fig. 2D).

Just after the ICA ligation, however, an acute encephalocele became apparent. She was given 250 mL of 20% mannitol with the least delay possible. The hyperventilation was performed, and the $PaCO_2$ ranged from 25 to 30 mm Hg, indicating lowered intracranial pressure. These measures were not making an obvious difference, however, so 1 mL of 0.02% nicardipine hydrochloride was injected to reduce the mean arterial pressure, but the encephaledema and encephalocele persisted. To prevent detachment of the thrombosis, we did not open the ICA. After rapid surgical exploration revealed nothing, the skull flap was removed. The patient was transferred to the neurologic intensive care unit and remained sedated until the next morning. When she awoke next day, tracheal extubation was accomplished. Continuous intravenous pumping of 0.02% nimodipine was administered to prevent vascular spasm. Her systolic blood pressure was controlled at 120 to 140 mm Hg by administering

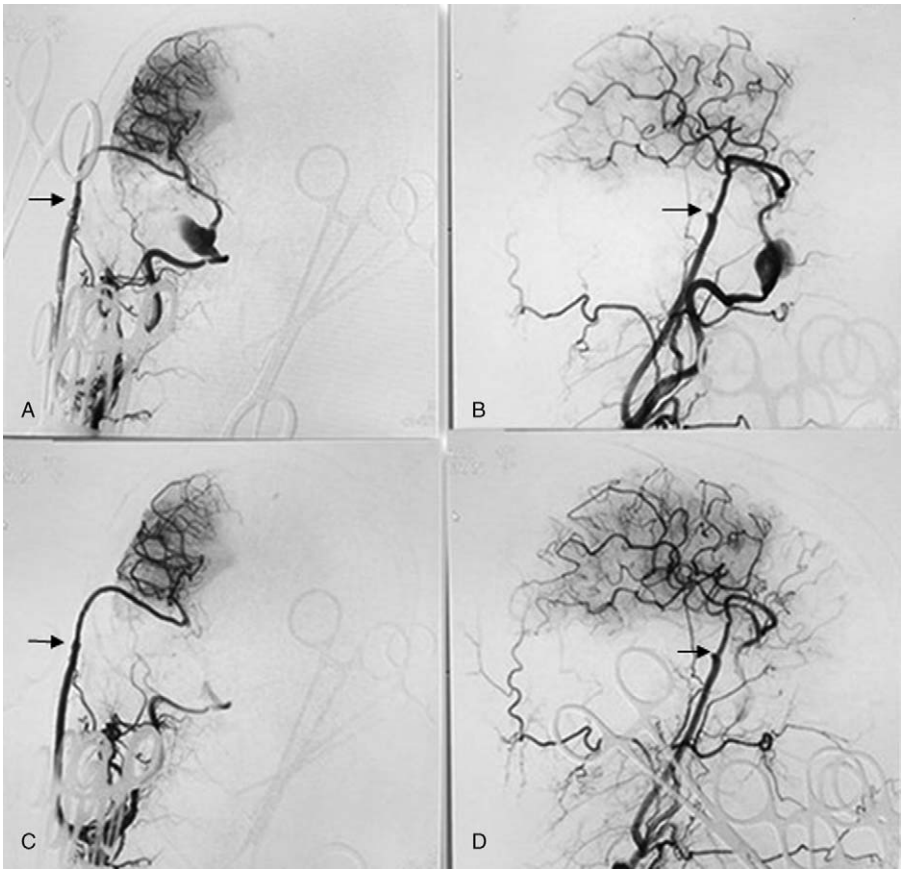

Figure 2. Intraoperative digital distraction angiography (DSA) was performed in the hybrid operating room. (A and B) The patency of graft (black arrow) is verified by the DSA after bypass. (C) The DSA shows the patency of graft (black arrow) and the aneurysm smaller after the internal carotid artery (ICA) narrowed. (D) The final intraoperative DSA shows the disappearance of aneurysm and the patency of bypass (black arrow) after the ligation of ICA. DSA = digital subtraction angiography, ICA = internal carotid artery.

125 mL of 20% mannitol every 8 hours. She was able to eat on postoperative day 3, after which the nimodipine was administered orally for 1 week.

The patient's symptoms gradually diminished, although she experienced left hemiparesis (modified Rankin scale score = 2). Postoperative computed tomography (CT) and CT angiography showed disappearance of the aneurysm and good patency of the bypass with the cranial defect (Fig. 3). After a 2-week hospital stay, she was discharged with aspirin for life. To date, we have followed her for 5 months without obvious further disappearance of her symptoms. The long-term effects remain to be seen with a longer follow-up.

Informed consent was acquired from the patient before the study. The case report has been approved by the Institutional Ethics Committee of Zhongnan Hospital.

3. Discussion

It is challenging to address giant cavernous sinus aneurysms with clips or coils alone.[4] In addition, the cost of treating a giant

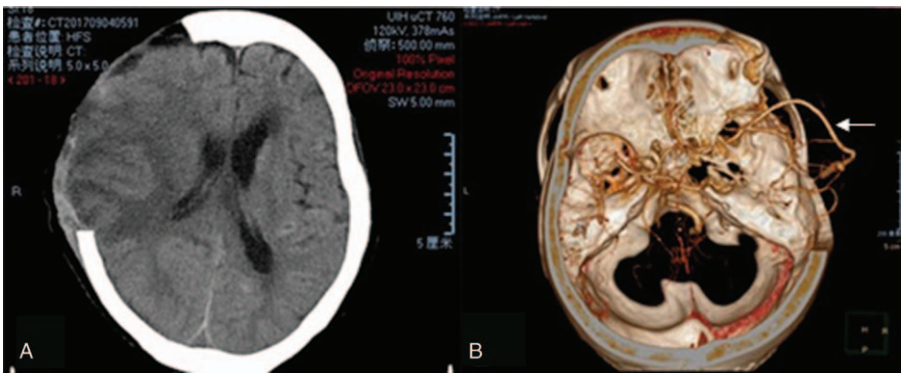

Figure 3. (A) Postoperatively, computed tomography (CT) shows the right frontal cortex edema and encephalomeningocele. (B) CT angiography verifies the good patency of graft (white arrow) and cranial defect. CT = computed tomography.

aneurysm with coils alone is far beyond what a common family in developing countries can afford. Using a hybrid operating room allows the performance of simultaneous procedures, including HFB and catheter intervention.[5] In this case, we treated a giant ICA aneurysm in the first biplane hybrid neuro-operating room in China, which features 2 large, flat detectors with high-definition imaging and advanced interventional tools that offered a clear view of vessel morphology. The "Double C" provided us with a more capacious work space and lower x-ray exposure, allowing us to operate faster and safer than before.

Matsukawa et al[1] performed HFB to compare using the saphenous vein (SV) versus the radial artery (RA) as a graft, finding that the RA graft had better patency than the SV graft. Ramanathan et al,[6] in contrast, did not find this to be the case in their study, perhaps because they used the vein from the thigh rather than from the leg, which has a higher caliber and a thicker wall. In addition, RA grafts appear to spasm more easily than SV grafts. Sekhar et al[7] indicated that the blood flow of RA grafts was 45 to 75 mL/min, which is lower than that of SV grafts (70–140 mL/min).[8] In addition, stripping the SV seems to be more convenient, and the length of the SV graft was easily determined.[7] Thus, the selection of grafts continues to be controversial. We admit that SV grafts are also more likely to cause kinking, but in this case we did not encounter that problem based on intraoperative DSA. Although vessel conditions are generally poor in elderly patients, thrombosis of the graft did not occur intraoperatively.

The patient developed an encephalocele just as we were ligating the ICA. Because of the risk of microemboli from the aneurysmal thrombus to the distal ICA,[9] we did not open the ICA. This dangerous condition could relate to the timing of the ligation—that is, the ligation of the ICA might have led to brain edema. Awad et al.[10] observed new subcortical hyperintense lesions on magnetic resonance images of the brain after carotid occlusion owing to hemodynamic changes. When the ICA was occluded, hemispheric ischemic symptoms might have occurred even though the BOT was negative.[11–13] Although we tried HFB, blood flow to the brain was still insufficient, considering the increasing vascular risks of an elderly patient. Dual bypass could be an alternative for these patients in terms of the ischemic possibility because a superficial temporal artery–middle cerebral artery bypass could protect the bypass of a graft–M2 anastomosis.[1,14,15]

We also could not exclude the possibility of hyperperfusion unless single photon emission tomography was performed. That is, the acute intraoperative brain swelling in this case may have been caused by hyperperfusion due to the large caliber of the SV graft. Such patients could be treated with two-stage operations. The first stage would involve HFB using an SV or RA graft after sufficiently evaluating the risks, followed by a second stage using a balloon to occlude the ICA. The anastomosis heals during the second stage. This procedure not only offers an opportunity to perform the BOT again, but it also allows adaptation to hemodynamic changes, which guarantees the safety of the occlusion.

Once an intraoperative encephalocele occurs, in any case, it is a catastrophic condition for both surgeon and patient. An increasing intracranial pressure compresses the surrounding structures, resulting in irreversible neurologic deficits.[16] If mannitol and hyperventilation fail to make a difference during the operation, internal decompression and cranial flap removal should be the alternative, thereby preventing further neurologic deficit[17]—which is why we undertook decompressive craniectomy with flap removal in this patient.

4. Conclusion

HFB is more easily performed in a biplane hybrid operating room, but only after the cerebral blood flow has been adequately evaluated preoperatively. Second-stage occlusion should be considered, even though occlusion of the ICA after bypass is indispensable, especially in elderly patients.

Author contributions

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Visualization: J. Zhang.
Writing – original draft: C. Xin.
Writing – review & editing: C. Xin, J. Zhang, J. Chen.

References

[1] Matsukawa H, Tanikawa R, Kamiyama H, et al. Graft occlusion and graft size changes in complex internal carotid artery aneurysm treated by extracranial to intracranial bypass using high-flow grafts with therapeutic internal carotid artery occlusion. Neurosurgery 2017;81:672–9.
[2] Matsukawa H, Tanikawa R, Kamiyama H, et al. The valveless saphenous vein graft technique for EC-IC high-flow bypass: technical note. World Neurosurg 2016;87:35–8.
[3] Chalouhi N, Theofanis T, Jabbour P, et al. Safety and efficacy of intraoperative angiography in craniotomies for cerebral aneurysms and arteriovenous malformations: a review of 1093 consecutive cases. Neurosurgery 2012;71:1162–9.
[4] Tajima H, Araki Y, Izumi T, et al. Coiling of a ruptured large internal carotid artery aneurysm via extracranial-intracranial saphenous vein bypass graft just after proximal ligation of the internal carotid artery. World Neurosurg 2017;98:879e1–4e.
[5] Nakajima N, Nagahiro S, Satomi J, et al. Prevention of retrograde blood flow into large or giant internal carotid artery aneurysms by endovascular coil embolization with high-flow bypass: surgical technique and long-term results. World Neurosurg 2015;83:1127–34.
[6] Ramanathan D, Temkin N, Kim LJ, et al. Cerebral bypasses for complex aneurysms and tumors: long-term results and graft management strategies. Neurosurgery 2012;70:1442–57.
[7] Sekhar LN, Duff JM, Kalavakonda C, et al. Cerebral revascularization using radial artery grafts for the treatment of complex intracranial aneurysms: techniques and outcomes for 17 patients. Neurosurgery 2001;49:646–58.
[8] Sekhar LN, Kalavakonda C. Cerebral revascularization for aneurysms and tumors. Neurosurgery 2002;50:321–31.
[9] Ezura M, Takahashi A, Yoshimoto T. Combined intravascular parent artery and ophthalmic artery occlusion for giant aneurysms of the supraclinoid internal carotid artery. Surg Neurol 1997;47:360–3.
[10] Awad IA, Masaryk T, Magdinec M. Pathogenesis of subcortical hyperintense lesions on magnetic resonance imaging of the brain. Observations in patients undergoing controlled therapeutic internal carotid artery occlusion. Stroke 1993;24:1339–46.
[11] Sekhar LN, Sen CN, Jho HD. Saphenous vein graft bypass of the cavernous internal carotid artery. J Neurosurg 1990;72:35–41.

[12] Origitano TC, al-Mefty O, Leonetti JP, et al. Vascular considerations and complications in cranial base surgery. Neurosurgery 1994;35:351–62.
[13] Roski RA, Spetzler RF, Nulsen FE. Late complications of carotid ligation in the treatment of intracranial aneurysms. J Neurosurg 1981; 54:583–7.
[14] Matsukawa H, Tanikawa R, Kamiyama H, et al. Risk factors for neurological worsening and symptomatic watershed infarction in internal carotid artery aneurysm treated by extracranial-intracranial bypass using radial artery graft. J Neurosurg 2016;125:239–46.
[15] Ishishita Y, Tanikawa R, Noda K, et al. Universal extracranial-intracranial graft bypass for large or giant internal carotid aneurysms: techniques and results in 38 consecutive patients. World Neurosurg 2014;82:130–9.
[16] Jasielski P, Głowacki M, Czernicki Z. Decompressive craniectomy in trauma: when to perform, what can be achieved. Acta Neurochir Suppl 2013;118:125–8.
[17] Honeybul S, Ho KM. The current role of decompressive craniectomy in the management of neurological emergencies. Brain Inj 2013;27:979–91.