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Case Report

Microsurgical embolectomy with superficial temporal artery-middle cerebral artery bypass for acute internal carotid artery dissection: A technical case report

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ABSTRACT

Background: Dissection of the internal carotid artery (ICA) is an important cause of stroke. Intravenous alteplase administration and mechanical thrombectomy have been strongly recommended for selected patients with acute ischemic stroke. However, the efficacy and safety of these treatments for ischemic stroke due to ICA dissection remain unclear. Here, we report a case of acute ICA dissection successfully treated by microsurgical embolectomy.

Case Description: A 40-year-old man presented with sudden left hemiparesis and in an unconscious state, with a National Institutes of Health Stroke Scale score of 14. Preoperative radiologic findings revealed an ICA dissection from the extracranial ICA to the intracranial ICA and occlusion at the superior-most aspect of the ICA. A dissection at the superior-most aspect of the ICA occlusion could not be confirmed; therefore, a surgical embolectomy with bypass was initiated. It became apparent that the superior ICA occlusion was not due to dissection but rather to an embolic occlusion; therefore, we undertook a surgical embolectomy and cervical ICA ligation with a double superficial temporal artery-middle cerebral artery bypass. The postoperative course was uneventful and, at the 6-month follow-up, the Modified Rankin Scale score for this patient was 1.

Conclusion: Surgical embolectomy with or without bypass can safely treat acute ischemic stroke due to an ICA dissection that cannot be distinguished between a dissecting occlusion and an embolic occlusion. Thus, it may be considered as an alternative option for patients in whom mechanical thrombectomy has failed or for those who are ineligible for mechanical thrombectomy.

Keywords: Acute ischemic stroke, Internal carotid artery dissection, Pathologic finding, Superficial temporal artery-middle cerebral artery bypass, Surgical embolectomy

INTRODUCTION

Dissection of the internal carotid artery (ICA) is an important cause of stroke in younger patients.[12] Intravenous alteplase administration and mechanical thrombectomy have been strongly recommended for selected patients with acute ischemic stroke.[11] However, the efficacy and safety of these treatments for ischemic stroke due to ICA dissection remain unclear. Concerns have been raised regarding these interventions and it has been suggested that these techniques could result in additional dissection development in previously unaffected vessels, pseudoaneurysm formation, or vessel rupture. However, microsurgical embolectomy is being performed less frequently due to a lack of evidence and fewer experienced neurosurgeons and surgical systems. Here, we report a case involving the successful treatment of acute ischemic stroke

due to ICA dissection using microsurgical embolectomy with bypass. To the best of our knowledge, this is the first reported pathological finding of an embolus due to an ICA dissection.

METHODS

Presentation

This study was approved Institutional Review Board with patients consent. A 40-year-old man with a history of uncontrolled hypertension presented with sudden left-sided hemiparesis. He was unconscious, with a National Institutes of Health Stroke Scale score of 14. Magnetic resonance imaging (MRI) was immediately performed [Figures 1 and 2]. Time-of-flight magnetic resonance angiography showed an intimal flap on the C3 and C7 carotid arteries. Digital subtraction angiography (DSA) was immediately performed for mechanical thrombectomy. Tissue plasminogen activator (tPA) was not administered because we suspected dissection of the cerebral artery, given his young age and negative presence of atrial fibrillation on electrocardiography. DSA showed irregular narrowing of the C7 ICA and at the superior-most aspect of the ICA occlusion [Figure 2].

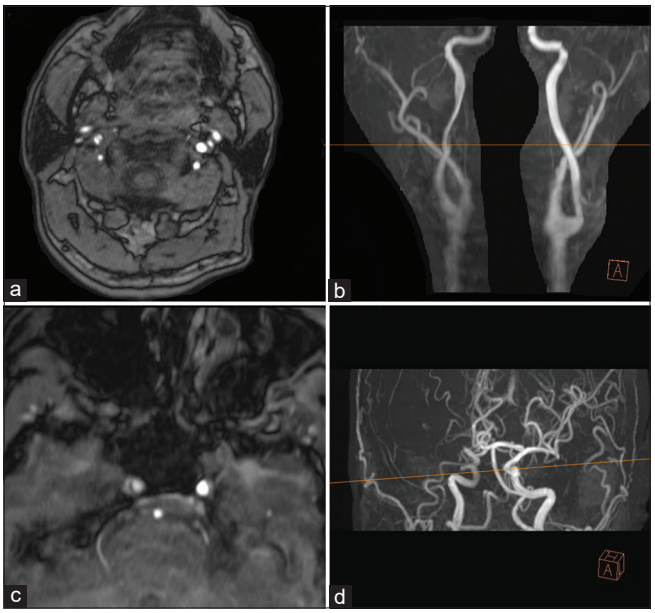

Figure 1: Time-of-flight (TOF) magnetic resonance angiography at onset. (a) A double lumen sign is identified in the C7 segment of the internal carotid artery (ICA). (b) 3D TOF showed narrowing of the C7 portion of the ICA. The line represents the reference line of figure (a). (c) A double lumen sign is identified in the C3 segment of the ICA. (d) The line represents the reference line of figure (c).

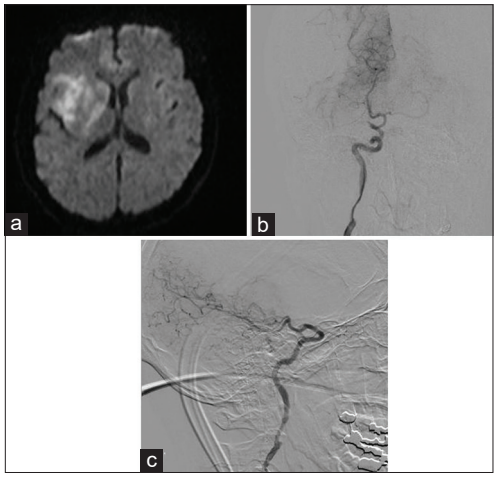

Figure 2: Diffusion-weighted image (DWI) and digital subtraction angiography. (a) DWI showed infarction of the posterior limb of the internal capsule, basal ganglia, and the insular and frontal cortices. (b and c) Digital subtraction angiography showed C7 narrowing and the superior-most aspect of the ICA occlusion.

Treatment strategy

We deemed that occlusion of the superior-most aspect of the ICA was either due to an embolic occlusion or an arterial dissection that developed in the C1 segment of the ICA. We decided that a dissecting occlusion could not be excluded in this case for the following reasons: (1) on MRI, the dissection appeared to spread along the C3 segment of the ICA and (2) the anterior choroidal artery was included in the infarction. Hence, we could not exclude the possibility of the dissection spreading to the C1 segment of the ICA. Based on these findings, a surgical embolectomy with bypass was planned.

Surgical approach (video)

A pterional approach which involved harvesting the frontal and parietal branch of the superficial temporal artery (STA) was performed. Following a frontotemporal craniotomy, the Sylvian fissure was opened widely to identify the M1–M3 segments of the middle cerebral artery (MCA). The MI segment appeared black in color and was occluded. Initially, the STA of the M3 segment of the MCA bypass secured distal blood flow. Then, an additional dissection was performed to identify the ICA. The posterior communicating artery was secured; however, the anterior choroidal artery was occluded by a white thrombus. Furthermore, the C1 segment of the ICA showed no evidence of dissection. The anterior choroidal artery was recanalized by massage. An arteriotomy was then performed on the M2 segment of the MCAs superior trunk to determine whether the occlusion was either due to an embolus or the development of an ICA dissection. In our patient, the occlusion was embolism related; therefore, the M1-M2 segment was recanalized by removing the embolus with no evidence of an MCA dissection. A parietal-branch STA-MCA bypass was undertaken, after which the MCA

pressure was monitored through the other small branch of the STA. MCA pressure monitoring was performed to determine whether the cerebral blood flow was adequate, or whether the ICA was occluded.[8] If the ICA is not occluded, an additional embolic stroke or a further ICA occlusion may occur postoperatively. The MCA pressure was secured to >80% before the ICA occlusion; therefore, we considered that an STA-MCA double bypass was sufficient post-ICA occlusion. The cervical ICA was then exposed and ligated. The time course for the procedure is outlined in [Figure 3].

Postoperative course

Postoperative diffusion-weighted imaging showed no additional infarction [Figure 4] and the patient's hemiparesis dramatically improved. After continuing +rehabilitation, he was discharged with mild left-sided unispacial neglect and cognitive dysfunction. Six months later, his Modified Rankin Scale score was 1.

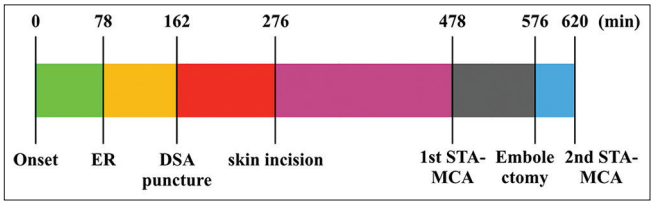

Figure 3: Treatment time course. Surgical embolectomy began 198 min after the patient was admitted to the emergency room. Superficial temporal artery-middle cerebral artery bypass was completed 2 h after skin incision (6.7 h after onset), and complete recanalization was established 8.3 h (498 min) after onset.

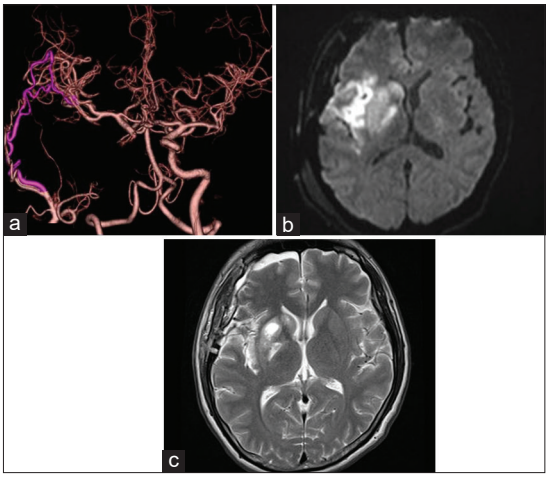

Figure 4: Postoperative imaging. (a) computed tomography angiography showed good patency of the superficial temporal artery-middle cerebral artery bypass and recanalization at the superior-most aspect of the internal carotid artery. (b) Diffusion-weighted image showed no additional infarction. (c) T2 imaging 2 weeks postonset showed hyperintensity on the posterior limb of the internal capsule and basal ganglia.

Pathological findings

Pathological findings of the removed thrombus using Elastica-HE, Elastica van Gieson, CD3, CD20, CD34, and CD 68 stains showed a red thrombus that included elastic fibers, calcification, and infiltration of T and B cells and macrophages [Figures 5 and 6].

DISCUSSION

While it was not apparent in our patient until after beginning the intervention, the dissection had not developed not only in the intradural segment of the ICA but also in the MCA. Hence, treatment could have been undertaken through mechanical thrombectomy with stenting of the dissection site. However, our case is important in this regard for the following reasons. First, an initial diagnosis of the dissection length of the ICA in the acute phase and a treatment strategy was not

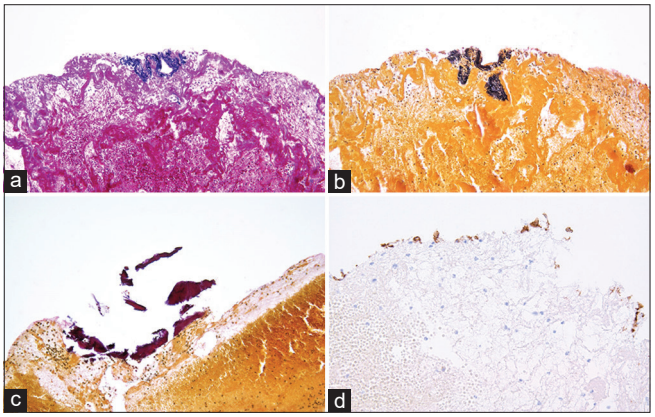

Figure 5: Pathological findings. Within the red thrombus, the internal elastic lamina is included in the Elastica-HE (a) and Elastica van Gieson stain (b). Calcification was also identified by Elastica van Gieson stain (c). CD34+ cells are identified in the thrombus (d).

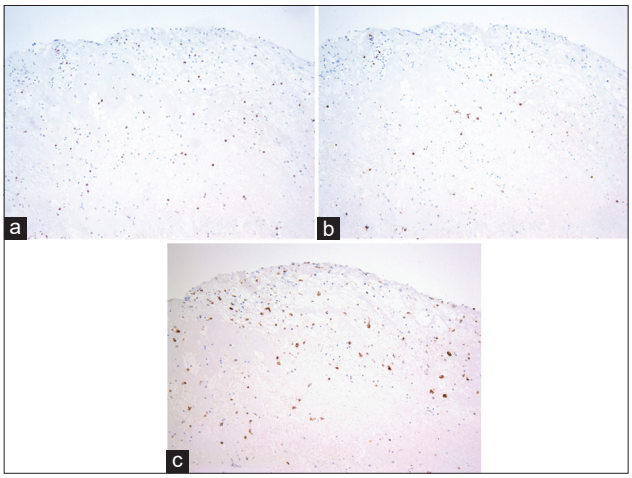

Figure 6: Thrombus characteristics. CD3+ (a), CD20+ (b), and CD 68+ (c) cells are infiltrated in the thrombus.

established. Second, surgical embolectomy can be used as a third-line treatment strategy for acute embolic stroke.

Assessing ICA dissection length

Among reported cases concerning ICA dissection, many cases have involved cervical ICA dissection. Ischemic stroke due to cervical ICA dissection in young and middle-aged patients comprises 8–25% of ischemic stroke incidence,[12,13] while intracranial ICA dissection is relatively rare.[1] In addition, rare cases have been reported concerning extension of the dissection from the extracranial ICA to the intracranial ICA.[15] Hence, assessing the length of the dissection is very important and should be undertaken using MRI. Angiographically, a normal vessel is not always an intact vessel;[10] therefore, the string sign of the dissection is only due to narrowing of the true lumen by the intramural hematoma, while the pearl sign is due to dissection extending into the adventitia. Thus, diagnosis of vessel wall pathology is essential; additionally, some MRI sequencing can detect mural hematoma.[14,15] However, in our patient, diagnosis of mural hematoma in the hyperacute phase was difficult using the current sequencing. Differential diagnosis of a dissecting occlusion or embolic occlusion was thus difficult in the present case.

Treatment of embolic stroke due to ICA dissection

One study reported eight cases of mechanical thrombectomy for ischemic stroke due to ICA dissection from the Merci Registry, which is a prospective, multicenter postmarket database comprising patients treated with the Merci Retriever thrombectomy device.[4] In that study, the results were favorable with only one case of extension of the dissection due to a microcatheter, and treatment was effective with stenting. However, it also included a report of a hemorrhagic case. If there is a misdiagnosis of dissection and embolus, a fatal subarachnoid hemorrhage may occur. In cases of intracranial dissection, the possibility of a rupture should always be considered during endovascular treatment, as a rupture could be fatal. Endovascular treatment is first choice treatment for extracranial ICA dissection with artery to artery embolism. Because embolic occlusion and dissection can be treated at 1 time. However, if cerebral artery occlusion due to intracranial dissection was suspected, open surgery should be another choice until effective diagnostic methods for determining dissecting occlusion and embolic occlusion have been established. If a dissecting occlusion is identified intraoperatively, performing a STA-MCA bypass to secure distal blood flow can be accomplished routinely.

Surgical embolectomy as a third-line treatment strategy involving recanalization following embolic stroke

There is strong evidence for undertaking endovascular revascularization for acute embolic stroke following administration of intravenous tPA. However, in some cases, this procedure cannot be performed, such as in patients with iodine enhancement allergy, access difficulties because of severe atherosclerotic change or anatomical variation, embolic stroke due to carotid plaque rupture,[7] or atherosclerotic occlusion. In such cases, surgical revascularization should be considered a third-line treatment strategy. Recanalization should be undertaken as early as possible; the DAWN trial showed that some patients could successfully treated within 24 h of stroke onset.[9] Surgical embolectomy can be performed within this timeframe. Although evidence for surgical embolectomy is not fully conclusive, the technique is relatively easy to perform with reports substantiating its effectiveness,[5-7] indicating that use of this technique should be considered.

Pathophysiology of the ICA dissection

In our case, the histopathological findings concerning the embolus showed that intima, internal elastic lamina, and calcification were included in the thrombus. In addition, some inflammation cells such as T and B cell and macrophages had infiltrated. Dargazanli *et al*. reported that the CD3+ T-cell count in intracranial thrombi was significantly higher in atherothrombotic origin strokes compared to that in all other causes and that thrombi with high content of CD3+ cells are more likely to originate from an atherosclerotic plaque.[2] These findings appear to support that the onset of dissection is middle-aged patients, which are a population younger than most patients with stroke, but do present with initial indicators of atherosclerotic change.[3]

Study limitations

Because this study involved a case of emergent ischemia, a detailed MRI study was insufficient in this case to determine the full extent of the diagnosis. In addition, in the future, studies should be performed involving case series or blinded protocols utilizing larger groups.

CONCLUSION

Acute ischemic stroke due to ICA dissection that cannot be distinguished from a dissecting or embolic occlusion can safely be treated using surgical embolectomy with or without bypass. This is a possible option for patients who have undergone mechanical thrombectomy or those who are ineligible for mechanical thrombectomy.

Declaration of patient consent

Institutional Review Board permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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