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Posterior Circulation Mechanical Thrombectomy through Primitive Trigeminal Artery: A Case Report

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Primitive trigeminal artery · Cerebral infarction · Mechanical thrombectomy

Abstract
Introduction: Primitive trigeminal artery (PTA) is a rare intracranial vascular malformation, and mechanical thrombectomy and revascularization via PTA are rarely reported. ***Case Presentation:*** We reported a case of mechanical thrombectomy through PTA in a patient who presented with sudden slurred speech and had a National Institutes of Health Stroke Scale score of 12. Digital subtraction angiography of the cerebral vasculature showed PTA formation in the right internal carotid artery cavernous segment, with acute occlusion of the distal basilar artery at the PTA junction, and bilateral vertebral arteries and proximal basilar artery were underdeveloped. Therefore, we chose mechanical thrombectomy via PTA, but unfortunately, the vessel failed to recanalize. Follow-up at 1-month post-procedure indicated that the patient had passed away. We present the endovascular process and analyze and summarize the reasons for the failure to provide a reference for subsequent mechanical thrombectomy via PTA. ***Conclusions:*** PTA increases the risk of ischemic stroke and adds to the complexity of mechanical thrombectomy post-stroke. However, in certain situations, PTA can be used as a thrombectomy channel to increase the first-line possibility of timely endovascular treatment to save ischemic brain tissue.

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Introduction

During embryonic development, the posterior circulation develops later than the anterior circulation, with the anterior circulation supplying the posterior circulation through multiple anastomotic branches. As the vertebrobasilar artery system matures, anastomotic vessels usually regress. However, in some cases, these vessels persist into adulthood; one is the primitive trigeminal artery (PTA). The prevalence of PTA is approximately 0.1–0.6% [1]. Generally, PTA is asymptomatic; however, it has been associated with various vascular disorders, including aneurysms, arteriovenous malformations, moyamoya disease, and large vessel occlusion [2]. Recently, PTA has also been reported to increase the risk of ischemic stroke [3, 4]. However, there are limited reports on PTA-related surgical treatments, which may be attributed to the PTA variants, tortuous course, small caliber, frequent association with vertebrobasilar artery dysplasia, and the difficulty and risk of the operation through PTA. We report an acute basilar artery occlusional cerebral infarction case confirmed by digital subtraction angiography (DSA). We suspected that basilar artery occlusion is an acute embolism caused by anterior circulation thrombus entering the basilar artery through PTA along the direction of blood flow. In this case, we chose the right internal carotid artery (ICA)-PTA approach, utilizing PTA as the access route for mechanical thrombectomy in the posterior circulation.

Case Presentation

A 66-year-old woman presented with sudden dysarthria and nausea and vomiting for 6 h upon admission. The patient's past medical history included cholecystectomy, meningioma resection, bilateral knee joint replacement surgery, and hypertension. Her vital signs were stable upon admission. Neurological examination revealed clouded consciousness with symmetric, round pupils, 2.0 mm in diameter, responsive to light. The extremities were mobile but without elicited tendon reflexes or Babinski signs. Due to the patient's inability to cooperate with further examinations, sensory, coordination, and Romberg's sign assessments were not possible. Her National Institutes of Health Stroke Scale (NIHSS) was 12.

Upon admission, the patient's glycated hemoglobin level, blood gas analysis, and novel coronavirus nucleic acid test results were negative. Table 1 shows the abnormal findings. The patient had abnormalities in coagulation function, providing a solid theoretical basis for thrombus formation. Electrocardiogram and echocardiography showed no significant abnormalities. The patient had undergone a meningioma resection surgery 7 years ago; however, the emergent head computed tomography (CT) scan ruled out intracranial space-occupying lesions or hemorrhage. Due to the 6-h delay from symptom onset to the arrival at the emergency room, intravenous thrombolysis was not administered owing to the increased risk of cerebral hemorrhage of this therapy when the time window of 4.5 h was exceeded. The patient had a stroke-like onset, occurring 6 h earlier. CT excluded intracranial hemorrhage; the NIHSS score was 12, indicating large blood vessel occlusion. After a discussion with the patient's family, we performed a DSA examination to determine the presence of extensive vessel pathology and assess collateral blood flow. An endovascular mechanical thrombectomy was performed to salvage the ischemic penumbra when necessary.

A right femoral artery puncture was performed, and a catheter was placed at the bilateral carotid and subclavian arteries. Angiography revealed visible PTA with tortuous vessel course at the C4 segment of the right ICA (Fig. 1a, b), occlusion of the distal basilar artery at the PTA anastomotic site (Fig. 1a, b), and hypoplasia of the right vertebral artery with no visualization beyond V3 and no visualization of the left vertebral artery beyond V4 (Fig. 1c, d). DSA confirmed the diagnosis of acute posterior circulation stroke in the patient. Due to the

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Table 1. Abnormal laboratory findings in the patient

Laboratory tests	Results	Normal range
High-sensitivity C-reactive protein, mg/L	>5.0 ↑	0–3
C-reactive protein, mg/L	11.70 ↑	0–10
Aspartate aminotransferase, U/L	37 ↑	13–35
Alanine aminotransferase, U/L	52 ↑	7–40
Lymphocyte percentage, %	16.6 ↓	20–50
Neutrophil percentage, %	78.4 ↑	40–70
Absolute value of neutrophil, 10^9/L	6.83 ↑	1.8–6.3
Antithrombin, %	67 ↓	83–128
Activated partial thromboplastin time, s	47.7 ↑	25.4–38.4
Thrombin time, s	29.5 ↑	10.3–16.6
D-dimer quantification, μg/mL (FEU)	2.24 ↑	0–0.5
Fibrin degradation products, μg/mL	5.40 ↑	0–2.01

↑ : Higher than the normal reference range; ↓ : Lower than the normal reference range.

underdevelopment of vertebral arteries and the proximal basilar artery up to the PTA anastomotic site, posterior circulation thrombectomy was not feasible. Therefore, the right ICA and PTA were selected as the thrombectomy route.

We advanced a React™ 68 distal access catheter (Medtronic, Irvine, CA, USA) into the C1 segment of the right ICA. Subsequently, the Rebar™ 18 microcatheter and Synchro micro-guidewire were introduced and advanced to the proximal end of the thromboembolic segment in the basilar artery. However, we could not successfully traverse the occlusion, and the distal access catheter was challenging to advance. We suspected that the inability to cross the thrombotic occlusion segment with the Synchro microguidewire might be due to its low stiffness, while the difficulty in advancing the distal access catheter could be attributed to the pronounced tortuosity and small caliber of the PTA and insufficient support of the microguides. Consequently, we switched to a stiffer and more supportive microguidewire, Avigo, which allowed us to traverse the thrombotic occlusion segment successfully (Fig. 2a); however, we still could not advance the distal access catheter. Thus, we advanced the microcatheter to the distal end of the basal artery and deployed a Solitaire™ FR 4–20 stent retriever (Medtronic, Irvine, CA, USA) for thrombectomy. However, the thrombus was not retrieved, and the subsequent angiography revealed that the basal artery remained occluded with a small amount of contrast extravasation (Fig. 2d), suggesting a small amount of bleeding. We hypothesized that the focal bleeding be related to the puncture of small arteries while using Avigo microguidewire, as its strong support force can potentially cause mechanical injury and subsequent bleeding due to its relatively rigid material composition. Considering the patient's vascular variation, abnormal tortuosity, and stenosis in the mechanical thrombectomy path, the success rate of thrombectomy upon repeat attempts was expected to be extremely low. Therefore, we administered intermittent intra-arterial thrombolysis with urokinase 300,000 IU. Follow-up angiography showed persistent occlusion at the embolism site (Fig. 2b, c). Although complete reperfusion of the basal artery was not achieved, we decided to terminate the procedure to avoid further complications and bleeding.

A follow-up CT performed 24 h postoperatively revealed a new brainstem wedge-shaped hypodensity, indicating cerebral infarction (Fig. 2e) and patchy hyperdensity in the posterior part of the cerebral falx, suggesting hemorrhage. The patient remained sedated postoperatively with a NIHSS score of 28, symmetric, round pupils, 2.0 mm in diameter, sluggish to light, and

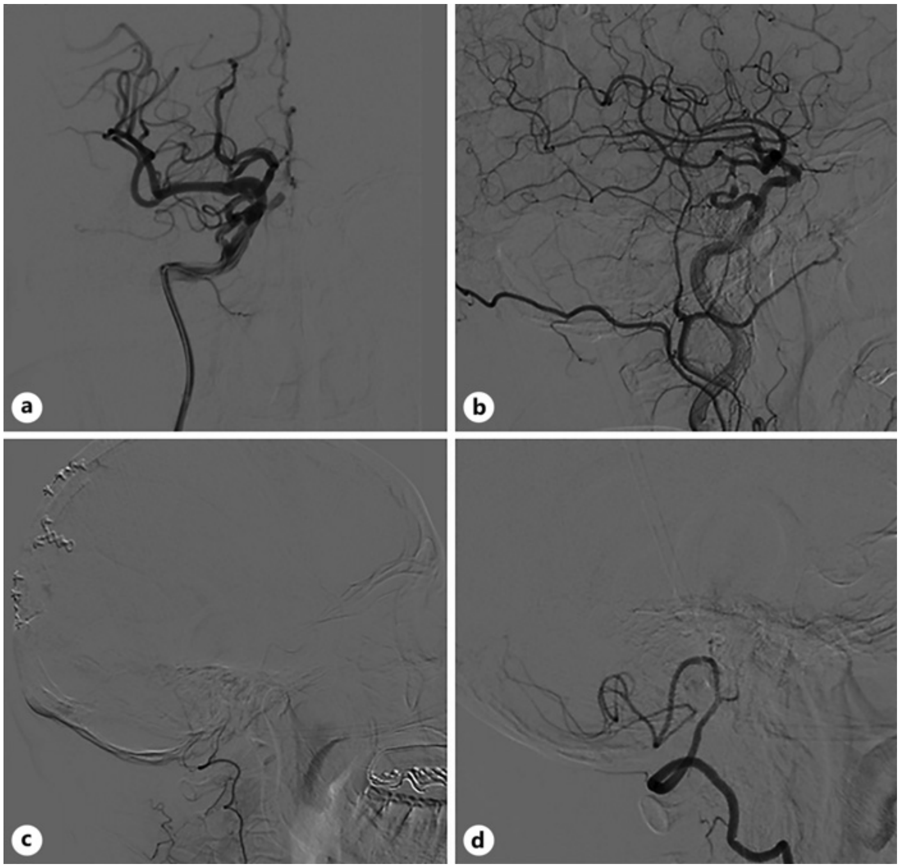

Fig. 1. Intracranial angiography before mechanical thrombectomy. **a**, **b** PTA and basilar artery thromboembolic site in positive and lateral angiography of the right ICA, respectively. **c**, **d** Lateral angiography of the right and left vertebral arteries, respectively.

assisted ventilation via a respirator. After discussing the patient's condition with the family, they automatically discharged the patient and signed the relevant documents. According to a follow-up phone call 1 month later, the patient had passed away. The CARE Checklist has been completed by the authors for this case report and attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000535871).

Discussion

PTA generally occurs on one side and is a relatively rare angiographic variation, which usually originates from the cavernous and petrosal segments of the ICA and terminates in the basilar artery [3, 5]. There is currently no unified classification for the PTA; however, the Saltzman classification is commonly used clinically [1]. Type I is characterized by bilateral supply to the superior cerebellar and posterior cerebral arteries by PTA, with poor development of the proximal basilar artery and bilateral posterior communicating arteries. Type II is characterized by PTA terminating at the proximal part of the superior cerebellar artery and supplying it, while the posterior cerebral artery is supplied by the patent posterior communicating artery. Type III involves direct anastomosis of PTA with cerebellar arteries without any connection to the basilar artery [6, 7].

In this case, PTA originated from the cavernous segment of the right ICA, with ipsilateral posterior communicating artery and vertebrobasilar artery dysplasia. This patient belongs to the

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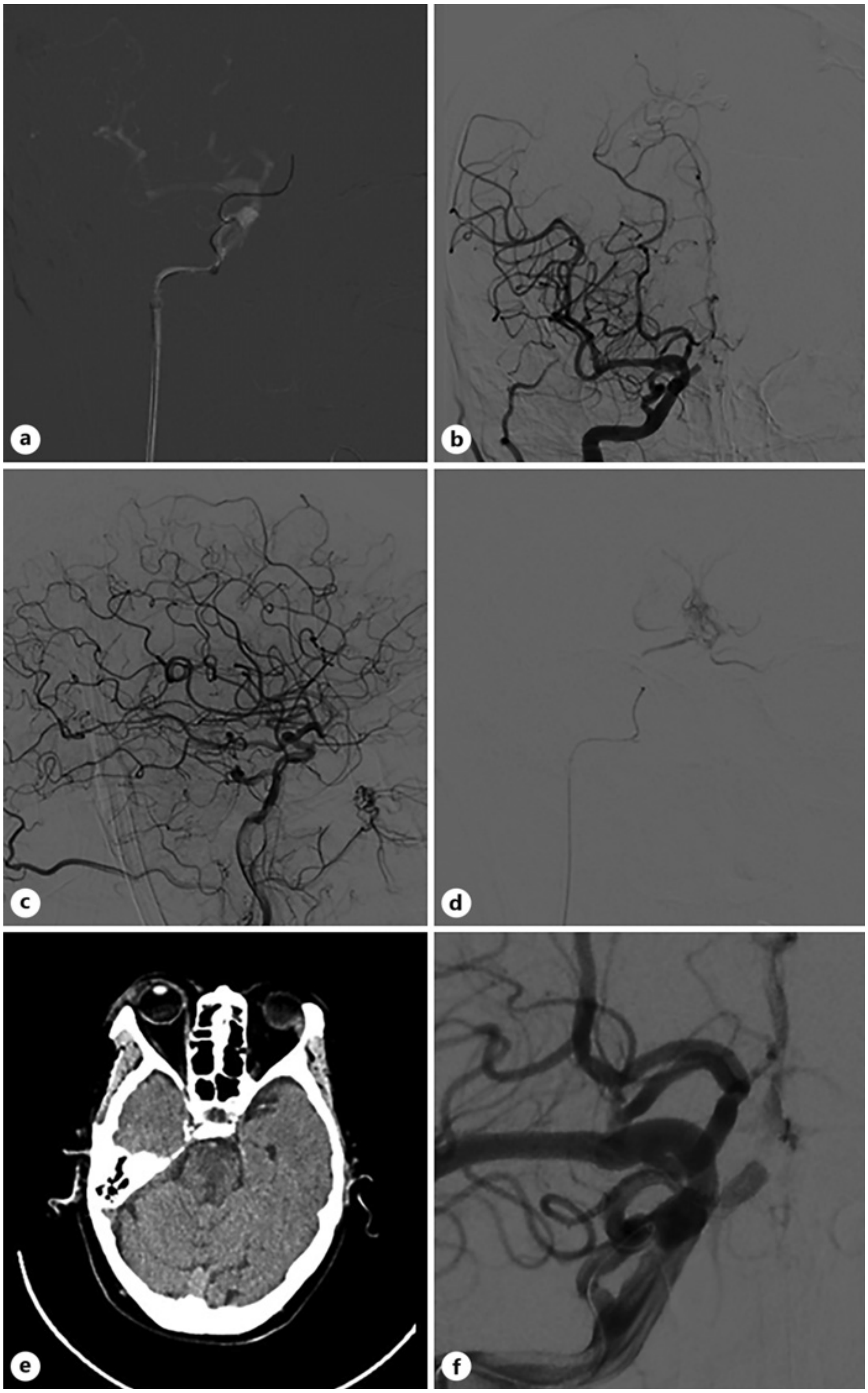

Fig. 2. Intraoperative and postoperative images. **a** Avigo microguidewire successfully traversing the thrombotic occlusion segment. **b**, **c** Postoperative right ICA angiography in positive and lateral views, respectively. **d** Intraoperative contrast extravasation. **e** Head CT examination 24 h after operative, showing brain stem infarction. **f** Diameters of the primitive trigeminal and basilar arteries.

type I according to the Saltzman classification. A meta-analysis demonstrated that 42.5% of patients with PTA have poor basilar artery development, leading to reduced blood supply in the posterior circulation [5]. In this scenario, blood flow through the PTA was directed from the ICA toward the basilar artery, making PTA a potential embolic pathway and significantly increasing the risk of posterior circulation embolism and ischemic stroke [3, 4]. Therefore, we believe that the basilar artery occlusion in this patient was most likely an acute embolism from the anterior circulation entering the basilar artery through the PTA. Endovascular thrombectomy is an effective method for treating large vessel occlusion strokes, significantly impacting patient prognosis [8]. However, there are few reports on endovascular treatment of PTA-related cerebral infarction. Till now, we have only found three reports of mechanical thrombectomy via PTA. Mulder et al. [9] reported a case of posterior circulation cerebral infarction successfully treated by PTA aspiration combined with mechanical thrombectomy with a Trevo stent retriever. Imahori et al. [10] also reported a patient with acute ischemic stroke involving anterior and posterior circulations. The operator used the Merci device to perform three mechanical thrombectomy attempts via PTA combined with local intra-arterial thrombolysis with urokinase and achieved partial recanalization. At the same time, in a patient with right ICA occlusion involving the PTA, Hiramatsu et al. [2] directly aspirated the thrombus at the proximal end of PTA, achieving successful recanalization. These reports show that PTA can serve as a potential embolic pathway and be an access route for thrombectomy, particularly in cases of vertebrobasilar artery hypoplasia.

However, in this case, mechanical thrombectomy was unsuccessful for various potential reasons. Analyzing the reasons for the procedural failure can provide valuable insights and guidance for subsequent endovascular treatment through the PTA. First, PTA variations are diverse. When patients have tortuous and small-caliber PTA, combined with developmental dysplasia of the vertebrobasilar arteries, it dramatically increases the difficulty and risk of endovascular treatment associated with poor prognosis for such patients. Second, the intraoperative bleeding may be related to replacing the soft and flexible microguidewires with the stiff guide wire, causing mechanical injury to the vascular endothelium. Therefore, when deciding on arterial thrombolysis, the underlying angiographic status of the patient should be considered. Especially with unfavorable angiography, choosing soft and flexible microguidewires whenever possible is advisable, using gentle manipulations and avoiding puncturing tortuous and poorly developed small blood vessels, which can lead to cerebral hemorrhage complications. Third, in this case, the diameter of the PTA and basilar artery was approximately 1.80 mm and 2.00 mm, respectively (Fig. 2f). However, the outer diameter of the distal access catheter used was approximately 2.00 mm, which was relatively large, making it difficult to advance and aspirate the thrombus at the proximal end of the basilar artery occlusion. This may be one of the critical reasons for the procedural failure. Therefore, when the distal access catheter cannot advance properly, it is essential to consider switching to a smaller caliber aspiration catheter and make another attempt.

Conclusion

In specific cases, PTA can serve as a treatment conduit for mechanical thrombectomy, providing a frontline opportunity for timely endovascular intervention to salvage ischemic brain tissue. Therefore, PTA and its role in endovascular therapy should be carefully considered when assessing and selecting treatment options.

Acknowledgments

Jiangjun Chen was not available to confirm co-authorship, but the corresponding author, Lihe Yao, affirms that Jiangjun Chen contributed to the paper, had the opportunity to review the final version to be published, and guarantees Jiangjun Chen's co-authorship status and the accuracy of the author contribution and conflict of interest statements.

Statement of Ethics

Written informed consent was obtained from the patient's next-of-kin for publication of the details of their medical case and any accompanying images. This study protocol was reviewed, and the need for approval was waived by the Ethics Committee of The First Hospital of Lanzhou University.

Conflict of Interest Statement

Xiaoshan Gao and Tianhong Wang both are first authors. Lithe Yao and Youquan Gu both are corresponding authors. The authors have no conflicts of interest to declare.

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Author Contributions

X.S.G. collected and analyzed the data and drafted the manuscript. T.H.W. participated in the data collection and made key revisions to the manuscript. C.J. interpreted the data and revised the manuscript. J.J.C. prepared Table 1. W.Y. and Y.K. prepared and edited the figures. L.H.Y. and Y.Q.G. provided the writing ideas and professional knowledge guidance. All authors read and approved the final manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this published article. Further inquiries can be directed to the corresponding author.

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