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Case Report

Successful endovascular thrombectomy using solitaire FR stent with intermediate catheter assisting technique for acute persistent primitive trigeminal artery and basilar artery occlusion: A case report and literature review

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ABSTRACT

Background: The persistent primitive trigeminal artery (PPTA) is a persistent embryological carotid-basilar connection. Endovascular thrombectomy (EVT) for hypoplastic PPTA occlusion is a challenge. This case report aims to describe the successful recanalization of simultaneous occlusions in both the PPTA and basilar artery (BA) using the Solitaire FR (RECO SR)/Stent and Intermediate Catheter Assisting (SWIM) technique in a patient with acute cardiogenic cerebral embolism. To the best of our knowledge, this is the first report of such a case.

Case Description: We present a case of a 70-year-old female patient who presented with acute right-sided hemiparesis and altered consciousness. Digital subtraction angiography confirmed the occlusion of both the distal portion of the PPTA and the BA. The patient underwent EVT using the SWIM technique, resulting in successful recanalization and significant improvement in the patient's condition.

Conclusion: This case report demonstrates the successful application of the SWIM technique in achieving recanalization and improving outcomes in a patient with simultaneous occlusion of the acute PPTA and BA. These findings support the potential use of EVT in similar cases.

Keywords: Acute cardiogenic cerebral embolism, Basilar artery, Endovascular thrombectomy, Occlusion, Persistent primitive trigeminal artery, Solitaire FR stent with intermediate catheter assisting technique

INTRODUCTION

The persistent primitive trigeminal artery (PPTA) is a rare embryological vascular anomaly that persists into adulthood.[11] Positioned between the internal carotid artery (ICA) and the basilar artery (BA), it boasts a prevalence in cerebral angiography ranging from 0.1% to 0.6%.[1,20] Recognized for its association with various cerebrovascular diseases, such as cerebral hemorrhage and ischemic stroke, the PPTA also relates to arteriovenous malformations, aneurysms, carotid-cavernous fistulas, and vascular nerve compression syndromes.[16,19]

Addressing ischemic strokes related to the PPTA presents distinct complexities for clinical neurologists.[3] Traditional endovascular thrombectomy (EVT) may be less than ideal, especially when dealing with the complex anatomy of the PPTA.[15,22] This accentuates the pressing need for innovative and advanced therapeutic methods tailored to such intricate cases.

The Solitaire FR (RECO SR)/Stent with Intermediate Catheter Assisting (SWIM) technique has emerged as a promising solution for these challenges. The SWIM technique is defined by its ability to navigate through tortuous and fragile blood vessels, minimizing the risk of proximal and distal embolisms, as well as reducing the potential for mechanical damage to the vessel wall.[10] This combination of devices makes the SWIM technique particularly effective in navigating the convoluted vessel structures associated with PPTA. Our neuro-interventional team has acquired extensive expertise in applying the SWIM technique, leading to successful treatments for numerous stroke patients.[9]

In this report, we present a compelling case of cerebral vascular occlusion successfully treated using the SWIM technique. Our patient presented with acute right-sided hemiparesis and altered consciousness. Diagnostic imaging confirmed the occlusion of the distal portion of PPTA and BA. Following the application of the SWIM technique, our patient experienced successful recanalization and significant improvement in her condition. This case highlights the SWIM technique's effectiveness in addressing cerebral vascular occlusions, underscoring its potential as a valuable treatment modality for such challenging cases.

CASE PRESENTATION

The patient, a 70-year-old female, presented with acute right-sided hemiparesis and altered consciousness, with a duration of 4 h and 46 min. On admission, her Glasgow Coma Scale (GCS) score was 11, and she scored four on the water swallow test. The National Institutes of Health Stroke Scale score was 14, reflecting the severity of her symptoms. She had a history of hypertension but denied diabetes mellitus, heart disease, and significant trauma or surgery. Noncontrast computed tomography (CT) on admission showed no evidence of hemorrhage or early ischemia [Figure 1a]. Electrocardiogram findings confirmed the diagnosis of atrial fibrillation (AF) [Figure 1b]. Laboratory tests revealed elevated levels of uric acid (356 μmol/L), D-dimer (1.82 μg/L), white blood cell count (10.11 × 10^9/L), and neutrophilic granulocyte percentage (84.8%). Liver and kidney function were within the normal range. Due to the patient presenting beyond the thrombolytic time window (>4.5 h), alteplase was not administered. According to Chinese guidelines for the diagnosis and treatment of acute ischemic stroke,[13] the patient received intravenous urokinase (UK) at a dose of 1 million units five hours after symptom onset, excluding contraindications.

However, approximately 30 min after the completion of UK treatment, her condition abruptly worsened, possibly due to a recurrent cerebral embolism caused by the dislodgment of a cardiac thrombus. At this stage, CT perfusion analysis was conducted using syngo.via software (Siemens, Erlangen, Germany). The analysis revealed a significant volume of penumbra (70 mL), the region of potentially salvageable brain tissue, and ischemic core (10 mL), the irreversibly damaged brain tissue, in the brain stem and cerebellar hemispheres [Figures 1c and d]. After ruling out hemorrhage and obtaining consent from the patient's family, an urgent endovascular intervention was promptly performed to ensure the patient's well-being.

Emergent digital subtraction angiography (DSA) revealed the following results: the termination of both the left vertebral artery (VA) and the right VA was observed in the posterior inferior cerebellar artery [Figures 2a and b]. Based on the imaging features, we observed a PPTA arising from the cavernous ICA [Figure 2c] and occluded near its distal end [Figure 2d]. Based on our observations, we postulate that the PPTA may supply the BA, bilateral superior cerebellar artery, and PCA. Furthermore, we speculate that the occlusion is likely located at the terminal segments of the BA and the PPTA. Consequently, we elected to employ the SWIM technique for EVT.

To initiate the procedure, we carefully positioned an 8F guide catheter (Boston Scientific, USA) at the origin of the right ICA, serving as the entry point for the intervention. Subsequently, we advanced an AXS Catalyst 6 distal access catheter (Stryker, USA) in conjunction with an XT-27 microcatheter (Stryker, USA), using a 0.014-inch synchro microwire (Stryker, USA). This intricate setup allowed for precise access to the occluded area associated with the PPTA, as depicted in Figure 3a.

The XT-27 microcatheter was then expertly navigated to the distal end of the thrombus, facilitated by the synchro 14. Following this, we introduced a RECO 4 × 20 mm stent retriever (Medtronic, USA) into the XT-27 microcatheter, positioning it strategically across the thrombus [Figure 3b]. After confirming the successful placement of the stent retriever, we carefully removed the XT-27 microcatheter from the setup. Subsequently, the AXS Catalyst 6 was connected to an aspiration tube and advanced to the proximal end of the thrombus.

To optimize the effectiveness of thrombus removal, we performed manual aspiration concurrently with the inflation of the Optimo balloon, creating a reverse flow. Finally, both the RECO stent retriever and AXS Catalyst 6 were meticulously withdrawn from the procedure. DSA was then employed to assess the results.

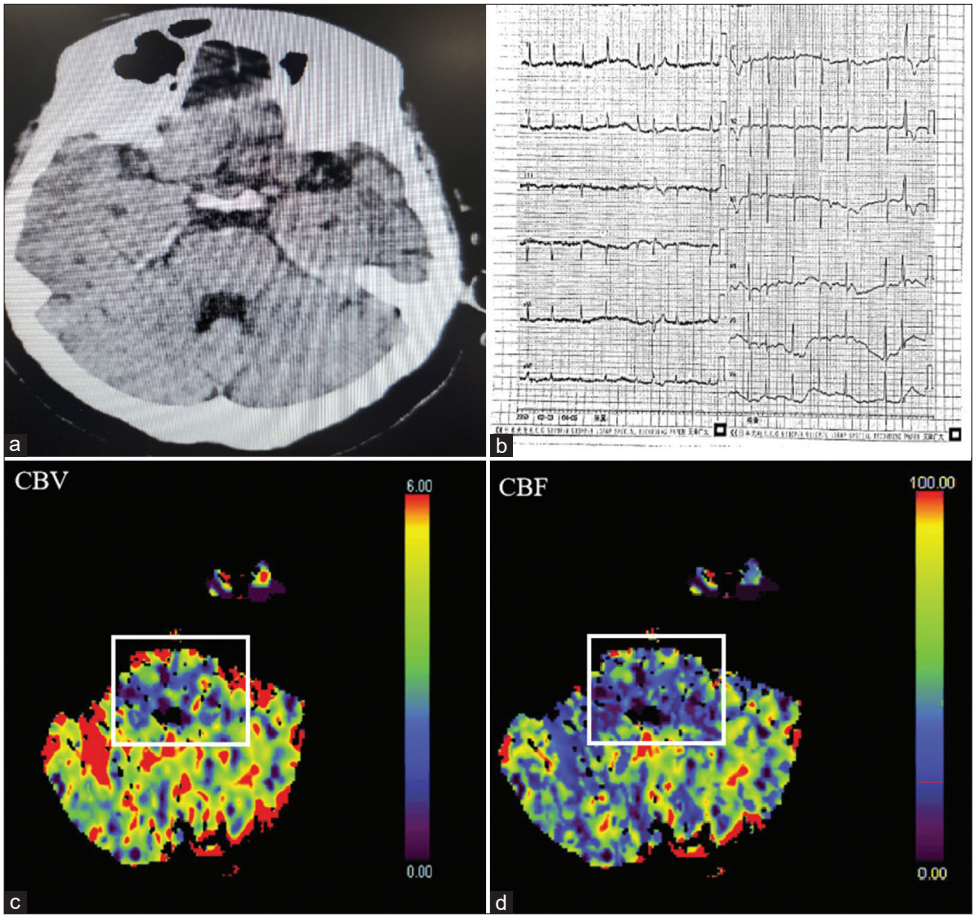

Figure 1: (a) Computed tomography (CT) showed no signs of hemorrhage or early ischemia; (b) electrocardiogram showed the cardiogram feature of atrial fibrillation; (c) preoperative CT perfusion (CTP)-cerebral blood volume (CBV) image demonstrated acute cerebral infarction involving the brainstem; solid lines of squares represented the ischemic core area with CBV <1.2 mL/100 mL; (d) preoperative CTP-cerebral blood flow (CBF) image displayed an area of penumbra in the brainstem; solid lines of squares represented the penumbra area with CBF <27 mL/100 g/min.

DSA confirmed the complete recanalization of the PPTA and the BA, achieving modified thrombolysis in cerebral infarction Grade 3 blood flow, as illustrated in Figures 3c and d. During the procedure, a substantial thrombus was successfully extracted from the occluded PPTA, as shown in Figure 3e. Importantly, no embolization to a new vascular territory (ENT)[6] was observed during the intervention. Following the procedure, the patient's symptoms and signs improved, leading to her transfer to a local township hospital. Unfortunately, due to a loss of contact with her family, the long-term outcome of her condition remains unknown.

DISCUSSION

PPTA is a rare vascular anomaly resulting from a persistent carotid-to-BA connection, typically regressing during embryonic development by day 14. However, in some cases, PPTA persists beyond this stage.[2] PPTA exhibits a complex relationship with the posterior circulation and significantly contributes to the blood supply of normal brain tissue. The management of PPTA occlusion remains challenging due to its anatomical complexity, necessitating practical approaches.[17]

Diagnosing PPTA and associated occlusions poses unique clinical challenges. Various imaging modalities, including DSA, computed tomography angiography (CTA), and magnetic resonance angiography (MRA), have been employed for diagnosis. However, thrombosis of the PPTA remains rare due to its distinctive anatomical characteristics.[5,21] Furthermore, the unusual and underreported association between AF, a common arrhythmia, and cardiogenic embolism leading to PPTA occlusion adds to the diagnostic complexity.

Our case presents a rare scenario where cardiac thrombi migrated to the brain, causing the simultaneous occlusion of both the PPTA and the BA, a previously undocumented occurrence. Clinical guidelines recommend prompt implementation of

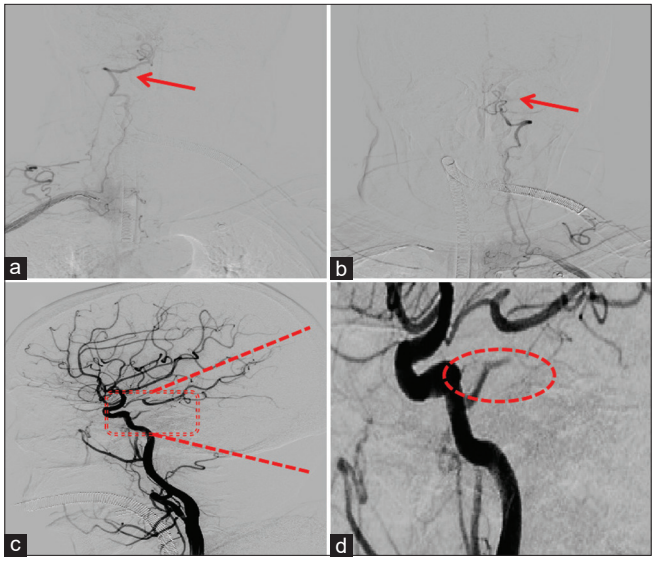

Figure 2: (a) Digital subtraction angiography (DSA) image indicating the left posterior inferior cerebellar artery (PICA) with a red arrow; (b) DSA image illustrating the hypoplastic right PICA (red arrow); (c) DSA image displaying the right posterior cerebral artery(PCA) and middle cerebral artery(MCA); the red dotted square highlights the presence of the persistent primitive trigeminal artery (PPTA) arising from the cavernous Internal carotid artery(ICA). In (d), the red dotted square is enlarged to reveal the absence of the terminal portions of the PPTA, as indicated by the red dotted oval curve.

complementary treatments, including thrombolysis and interventional therapy, on the diagnosis of acute cerebral infarction.[15] However, our case posed a unique challenge due to the occlusion pattern. While EVT through the VA is the conventional approach for recanalizing the occluded BA,[7] it was deemed inappropriate in this instance due to the patient's unique anatomy.

A detailed analysis of the angiography results revealed a PPTA originating from the right ICA and an occlusion in close proximity. Surprisingly, the PPTA was supplying the BA instead of the VA, necessitating a different approach. By selecting the ICA as the access route for EVT, we achieved successful recanalization of the occluded vessels. This case serves as an instructive example of the importance of tailored treatment strategies for unique vascular anatomies.

PPTA-related stroke poses a management challenge, marked by diverse outcomes documented in the existing literature. Our report delves into the contemporary treatment landscape for PPTA-related stroke, providing a comprehensive overview before introducing the innovative SWIM. Various treatment modalities have been explored for PPTA-related stroke, each yielding distinct outcomes. Medical management strategies vary, encompassing anticoagulation therapy and antiplatelet agents to prevent thromboembolic events associated with PPTA. In the acute phase, treatment may involve thrombolysis,[3] EVT, and

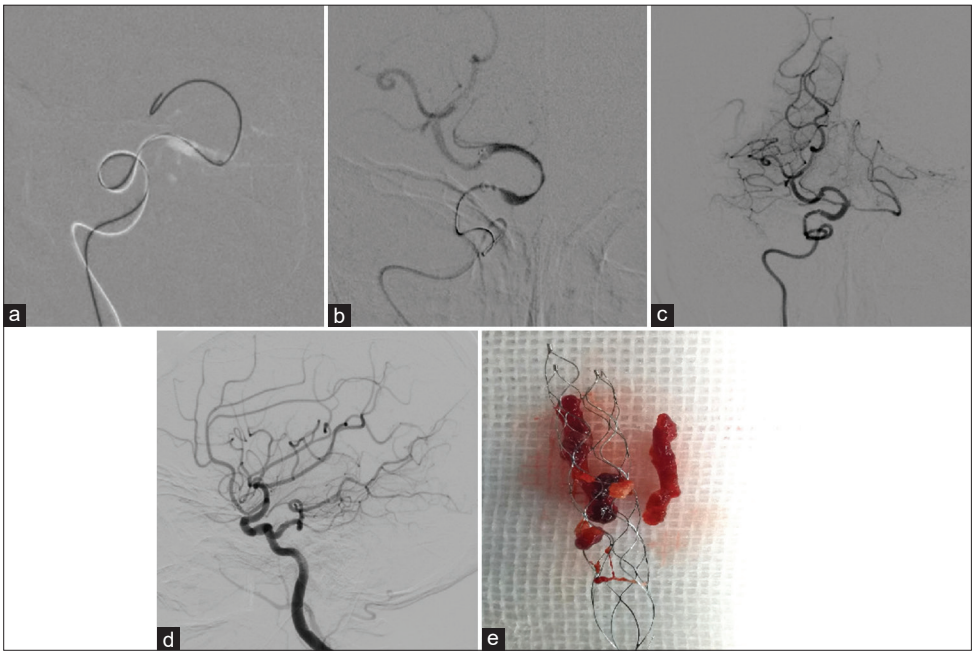

Figure 3: (a) Successful passage of a micro guidewire through the occlusion site, reaching the posterior cerebral artery (PCA); (b) images illustrating the basilar artery (BA) and PCA after deploying a revascularization with the embolization of a carotid occlusion (RECO) 4 ×20 mm stent, leading to vessel reperfusion; (c) visualization of the recanalized BA after stent retrieval; (d) digital subtraction angiography image depicting the presence of the PPTA, BA, PCA, middle cerebral artery, and PCA following the successful recanalization of the persistent primitive trigeminal artery (PPTA) and BA; (e) extraction of a firm thrombus from the occluded PPTA.

Table 1: Summary description of the treatment of cerebral infarction related to PPTA with EVT, as found in the literature review. Cases are ordered according to the time of case publication.

Identification	Symptoms	Arteries involved and Saltzman classification of PTA	Treatment	Patient outcome
62 yo F (2006)[4]	A transient episode of ill-defined visual disturbance and a mild right-sided hemiparesis	Right high-grade ICA stenosis (90%) with right PTA, Saltzman Type 1	ICA endarterectomy	No deficits
67 yo M (2015)[8]	Sudden loss of consciousness and quadriplegia	Right MCA and BA occlusion, Saltzman Type 1	MT of the MCA and the BA through the PPTA	Lucid and with moderate left hemiparesis
67 yo M (2015)[12]	Sudden loss of consciousness and left hemiparesis	Right ICA occlusion with PTA, BA, PCA and SCA hypoperfusion, right type 1	rt-PA and MT	Mild facial and left-hand paresis
76 yo M (2016)[14]	Mild dysmetria and intentional tremor affecting the right arm, tandem gait ataxia, and right-sided hemianopia, preceded several weeks by intermittent vertigo.	Left ICA stenosis (75%) and left PTA, BA hypoplasia below the PPTA, Saltzman Type 1	ICA endarterectomy	Resolution of the intermittent vertigo
65 yo F (2020)[6]	The left frontal lobe, parietal lobe, insular cortex, and corona radiata	occlusion of the left ICA distal to a PPTA Saltzman type 1	MT using a combined technique with a BGC, aspiration catheter, and stent retriever	At 6 months, her Modified Rankin Scale score was 2.

ICA: Internal carotid artery, BGC: Balloon guide catheter, MT: Mechanical thrombectomy, PCA: Posterior cerebral artery, SCA: Superior cerebellar artery, BA: Basilar artery, PPTA: Persistent primitive trigeminal artery, PTA: Persistent trigeminal artery, rt-PA: Recombinant tissue plasminogen activator, EVT: Endovascular thrombectomy, MCA: Middle cerebral artery, BGC: Balloon guide catheter, MCA: Middle cerebral artery

antiplatelet aggregation, expanding the spectrum of available choices.[5]

Against this backdrop of existing treatments, our case study introduces SWIM as a novel approach to PPTA-related stroke. SWIM aims to mitigate the risk of lingering symptoms and complications observed in prior cases. Our literature review, which includes a thorough examination of various treatment approaches, underscores the scarcity of reports on the successful application of EVT for PPTA-related stroke. To date, only five relevant cases have been documented, as summarized in Table 1. Our analysis reveals that, while all patients survived, only one case exhibited no residual symptoms. Conversely, the remaining three cases experienced varying degrees of sequelae, including hemiparesis and dizziness, highlighting the demand for innovative approaches like SWIM.

Known for its high recanalization rate and rapid restoration of cerebral blood perfusion,[10] the SWIM technique emerges as a promising avenue for addressing PPTA occlusions. This technique provides a novel method for achieving distal access, particularly in the presence of irregular and tortuous vessels,[18] incorporating mechanical thrombectomy as an effective means of thrombus removal.

CONCLUSION

This case illustrates the complexity and uniqueness of PPTA-related stroke, emphasizing the importance of tailored treatment approaches. It expands the limited body of evidence regarding the successful use of EVT, particularly the SWIM technique, in addressing PPTA occlusions. This case is the first reported instance demonstrating the successful application of the SWIM technique for PPTA-related stroke, further underscoring its potential as a valuable tool in the management of such cases.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent is not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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