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Original Paper

Recanalization of Tandem Vertebrobasilar Occlusions with Contralateral Vertebral Occlusion or Hypoplasia via either Direct Passage or the SHERPA Technique

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Stroke · Thrombectomy · Aspiration · Recanalization · Stent · Tandem vertebrobasilar occlusions

Abstract
Introduction: Tandem vertebral ostial disease with acute intracranial vertebrobasilar occlusion with contralateral vertebral occlusion or hypoplasia presents a unique challenge to the interventionalist. ***Methods:*** The authors queried a prospectively maintained institutional endovascular database from August 2013 to June 2018 for cases of endovascularly treated acute tandem vertebrobasilar occlusions in the presence of contralateral vertebral occlusive disease or hypoplasia. Demographic and presentation data, the technique, results, and clinical outcome were extracted. ***Results:*** Tandem recanalization was attempted and achieved in 5 patients with a thrombolysis in cerebral infarction (TICI) 3 result in 4 patients and a TICI 2c result in 1 patient. To facilitate effective manual aspiration thrombectomy for the tandem basilar occlusion, performed in all cases in 1 or 2 passes, the Neuron™ MAX sheath was advanced into the V2 after Dotter or balloon angioplasty of the diseased origin. In cases where the origin cannot be crossed/visualized, the Synchro Helper to Evaluate via Retrograde Passage an Arterial origin (SHERPA) technique, entailing the passage of a microwire retrograde via the hypoplastic contralateral vertebral artery was utilized to delineate the vertebral ostium (n = 2 cases). All but 1 patient had substantial improvement in the National Institutes of Health Stroke Scale score after the procedure. ***Conclusion:*** Recanalization of tandem vertebrobasilar occlusions with contralateral occlusion or hypoplasia is feasible. Intracranial recanalization is facilitated by the passage of a long 6F sheath into V2, and retrograde delineation of an occluded vertebral origin with a microwire may serve as a crucial adjunct.

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Introduction

The management of tandem vertebral ostial disease with acute intracranial vertebrobasilar occlusion is a rare challenge faced by the modern interventionalist. As described by Cohen et al. [1], there may be a normal vertebral artery for endovascular access, the "clean road," and a contralateral, diseased vessel, the "dirty road". The absence of a "clean road," in the context of contralateral vertebral occlusive disease or hypoplasia, poses a unique challenge. We review our experience with the management of this unique subset of acute tandem vertebrobasilar occlusions, focusing on the approach and results. We highlight the SHERPA technique (Synchro Helper to Evaluate via Retrograde Passage an Arterial origin) as a means to delineate the location of an occluded vertebral origin.

Methods

A prospectively maintained endovascular database was queried from August 2013 to June 2018 for cases of endovascularly treated acute tandem vertebrobasilar occlusions in the presence of contralateral vertebral complete occlusion or hypoplasia (a V4 diameter too small for an aspiration catheter or no "clean road"). This search yielded 5 patients (Table 1). Background patient demographic and presentation data, endovascular technique, results, and clinical outcome were extracted from the database.

Table 1. Summary of the treated cases: presentation, technique, and results

	Case 1	Case 2	Case 3	Case 4	Case 5
Age, years	66	64	78	63	57
Sex	Male	Male	Male	Male	Male
NIHSS score	8	14	30	28	27
Last normal, h	1	4	5	6	16
tPA	No	Yes	No	No	No
Anesthesia	IVCS	IVCS	Already intubated	Already intubated	Already intubated
Treated vert	Occluded	99% stenosis	Occluded	Occluded	Occluded
Contralateral vert	Occluded	Occluded	Terminates in PICA	Hypoplastic	Hypoplastic
Ostial angioplasty	Neuron MAX Dotter	4 × 20 mm Aviator balloon	Retrograde via deep cervical, 3 × 8 mm TREK balloon	3 × 15 mm TREK balloon SHERPA	3 × 15 mm TREK balloon SHERPA
Basilar thrombectomy	2 passes MAT ACE68 ACE60 for P1	1 PASS MAT CAT 6	1 PASS MAT 057 DAC	1 PASS MAT 0.072 Navien	2 PASSES MAT 0.072 Navien 0.038 DAC for P1
Ostial stent	3.5 × 18 mm Integrity	4 × 12 mm Integrity	4 × 8 mm Vision	4 × 16 mm Rebel	5 × 15 mm Rebel
TICI	2c	3	3	3	3
NIHSS PPD1	2	4	17	28	16
Disposition	Rehabilitation	Rehabilitation	Died	Died	LTAC

tPA, tissue plasminogen activator; IVCS, intravenous conscious sedation; Vert, vertebral artery; PICA, posteroinferior cerebellar artery; PPD, postprocedural day; LTAC, long-term acute care facility.

General Technique

In awake, nonintubated patients, procedures are performed under i.v. conscious sedation (n = 2). Patients who are already intubated in the context of their mental status are maintained under general endotracheal anesthesia (n = 3). Access is achieved with the placement of a Neuron™ MAX catheter in the common femoral artery. A diagnostic catheter is inserted through the Neuron MAX and used to delineate subclavian and intracranial vascular anatomy. After crossing the diseased vertebral origin with an exchange-length microwire, balloon (n = 4) or Neuron MAX Dotter angioplasty (n = 1) was performed as the catheter was advanced into the V2 segment. In all cases, reperfusion was subsequently achieved after 1 or 2 total passes via manual aspiration thrombectomy (MAT) with a 6 French aspiration catheter introduced through the long 6F sheath (Table 1) [2, 3]. After recanalization, an exchange-length wire was left in the V2 or V3, the Neuron MAX was withdrawn into the subclavian, i.v. integrilin was administered, and the diseased vertebral origin was stented over the wire. The patients were loaded and maintained on dual antiplatelet therapy after the procedure.

In 1 case with bilateral vertebral origin occlusions, an occluded, presumably dominant vertebral origin was primarily crossed antegrade with a Neuron MAX over a Vert catheter over a velocity microcatheter over a Synchro (case 1, Fig. 1). In another case with an occluded contralateral vertebral artery, a critical (99%) ostial stenosis of the dominant vertebral artery was visualized and primarily crossed antegrade with a Synchro wire (case 2). Origin balloon angioplasty (4-mm Aviator balloon) was then performed. In another case with a contralateral hypoplastic vertebral artery terminating in the posterior inferior cerebellar artery, retrograde balloon angioplasty of an occluded dominant vertebral artery origin was carried out by the passage of a microcatheter/microwire combination through a deep cervical artery collateral to the vertebral artery (case 3). This case was previously published [4]. In 2 cases, dominant vertebral artery occlusions were seen with opacification of the basilar artery through a patent but hypoplastic contralateral vertebral artery. In these cases, the SHERPA technique was used (cases 4 and 5).

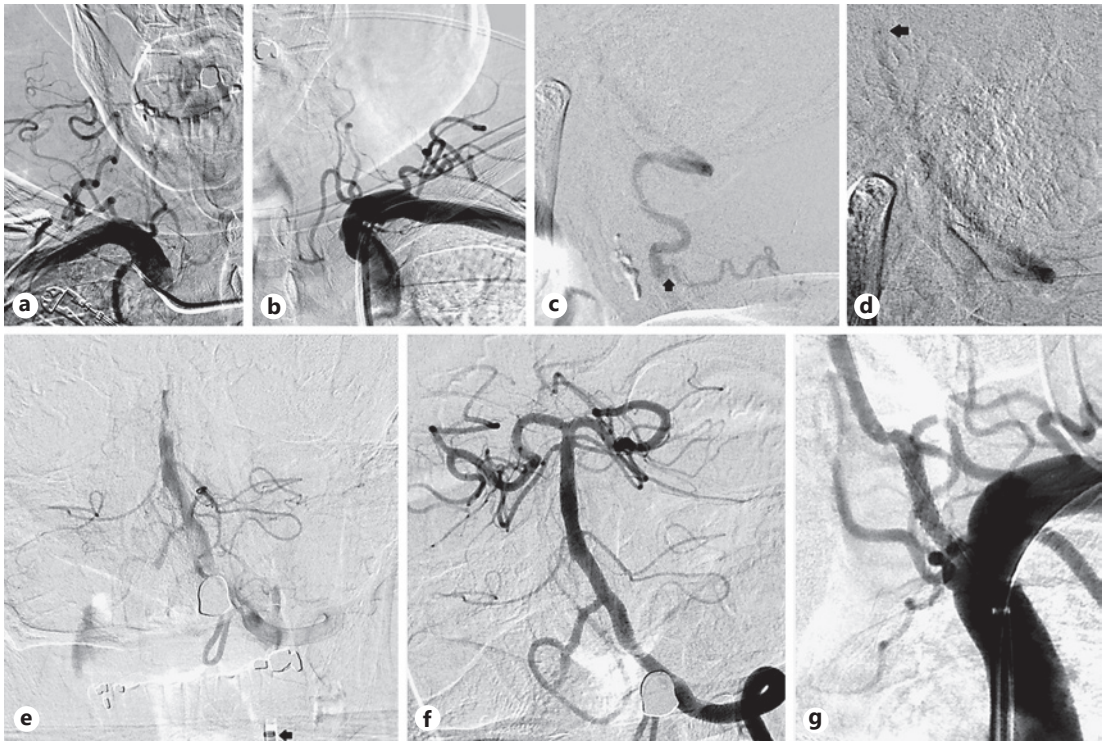

Fig. 1. Case 1. Angiography confirms occlusion of the right (**a**) and left (**b**) vertebral origins. Collateral via the deep cervical artery (**c**, lateral view, arrow) confirms a basilar occlusion (**d**, lateral view later phase, arrow). The Neuron MAX is advanced over a Vert catheter over a microcatheter/wire combination to the distal V2 (**e**, arrow), with angiography better delineating the basilar thrombus. After 2 passes of MAT, recanalization is achieved (**f**), and the vertebral artery ostium is subsequently stented over the microwire (**g**).

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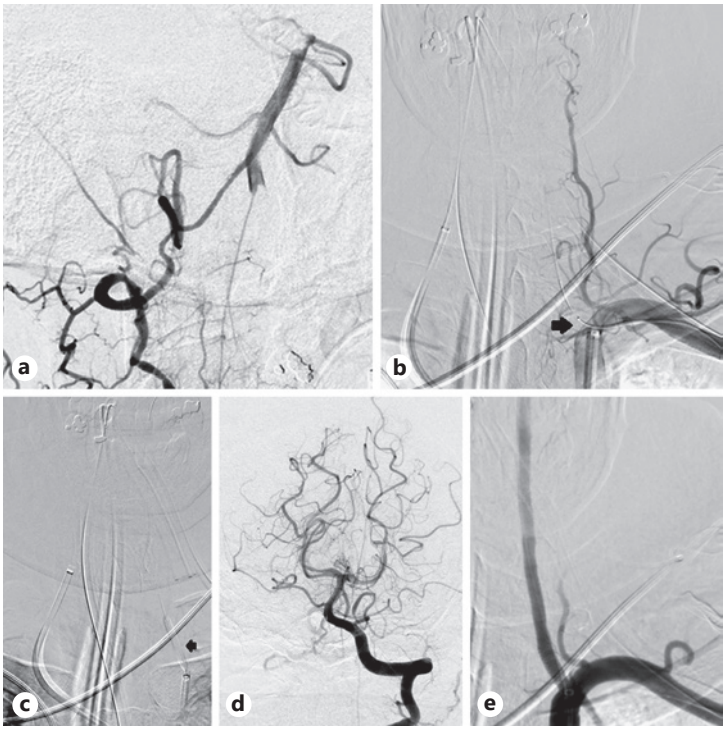

Fig. 2. Case 5. The SHERPA technique. Angiography via the contralateral hypoplastic vertebral artery confirms basilar thrombus (**a**). Stentriever thrombectomy and MAT with an 0.038-inch DAC failed. An exchange-length microwire is then passed to delineate the left vertebral artery ostium (SHERPA technique, **b**, arrow). Via the Neuron MAX in the left subclavian artery, a microcatheter/microwire combination is advanced across the occlusion. Angioplasty is performed with a 3-mm balloon (**c**, arrow). The Neuron MAX is advanced into the left V2, and basilar recanalization is achieved after 2 passes of MAT (**d**). The Neuron MAX is withdrawn into the subclavian artery, and the vertebral ostium is stented over an exchange-length microwire left across the lesion (**e**).

SHERPA Technique

In cases of contralateral vertebral artery hypoplasia that precludes thrombectomy but allows access to the dominant, occluded vertebral artery across the vertebrobasilar junction, an exchange-length Synchro microwire may be utilized as a guide or "SHERPA" to illustrate the location of the vertebral origin. The SHERPA technique necessitates bilateral groin access (Fig. 2).

In both cases, a Neuron MAX was inserted into the common femoral artery and advanced into the hypoplastic vertebral artery. In both cases, thrombectomy was attempted via the hypoplastic vertebral artery. In 1 case, 2 passes were made: one with a microcatheter used to deploy a stentriever followed by another where an 038 DAC was advanced over a microcatheter over a microwire through the hypoplastic distal V4 as the largest possible aspiration catheter. Both passes resulted in thrombolysis in cerebral infarction (TICI) 0 reperfusion. In the other case, only a microcatheter could be passed through the hypoplastic distal V4; a stentriever was deployed, but recanalization was not feasible.

Subsequently, via the Neuron MAX, a microcatheter/exchange-length Synchro microwire combination was advanced into the contralateral vertebral artery down to the origin to delineate its location, since no stump could be visualized antegrade. Contralateral femoral access was achieved with advancement of a Neuron MAX into the subclavian artery harboring the dominant vertebral artery. A microcatheter/exchange-length microwire combination was then advanced antegrade through the delineated vertebral origin. In both cases, over the exchange-length wire, angioplasty of the origin with a 3-mm TREK balloon was performed. Over the exchange-length microwire, through the Neuron MAX, the balloon was exchanged for an 0.072-inch Navien over an 0.027-inch microcatheter that were advanced into the distal vertebral artery, allowing for advancement of the Neuron MAX into the V2. In both cases, successful basilar MAT was performed with the 0.072-inch Navien catheter. In 1 case, an additional MAT pass was taken with an 0.038-inch DAC for a P1 occlusion. After thrombectomy, an exchange-length Synchro was maintained in the V3, the Neuron MAX was withdrawn into the subclavian artery, and the vertebral artery origin was stented.

Results

Tandem recanalization was attempted and achieved in all 5 patients with contralateral vertebral occlusion or hypoplasia (Table 1). All patients were male, and 3 presented obtunded with very high National Institutes of Health Stroke Scale scores (NIHSS; cases 3–5). In reviewing their history prior to presentation and after discussion with the patients' families, at least 3 of the patients had preceding vertiginous/presyncopal symptoms prior to their decline. Case 1 presented with minimal symptoms and known basilar thrombus with an NIHSS of 3. The patient was maintained on a heparin drip and subsequently abruptly deteriorated with a pressure-dependent examination. One patient (case 2) received tissue plasminogen activator. All patients who were not intubated were treated under minimal i.v. conscious sedation.

All but 1 treated vertebral artery origin were completely occluded. Ostial disease was atherosclerotic in all cases, and intracranial occlusions were presumably embolic from the ostial disease. In 2 cases with a present but hypoplastic contralateral vertebral artery, thrombectomy was first attempted via this artery but failed secondary to the inability to navigate an adequate caliber aspiration catheter into the basilar artery for effective MAT or stent-assisted MAT. In these cases, the SHERPA technique was used successfully. With access to the dominant vertebral artery, thrombectomy proceeded relatively swiftly with 1 or 2 passes of MAT in all cases. Ostial stent deployment was subsequently uneventful in all cases without residual ostial stenosis after deployment. Overall recanalization was TICI 3 in 4 cases and TICI 2c in 1 case.

All but 1 patient had substantial improvement in NIHSS score after the procedure; 1 obtunded patient had no improvement, while the other 2 obtunded patients had improved to following commands with a decrease in the NIHSS score by 11 and 13. Ultimately, 1 obtunded patient who did not improve expired, while another expired secondary to endocarditis (case 3). Both patients who did not present obtunded had significant improvement in NIHSS score and were discharged to rehabilitation. One case has recently been performed without longer follow-up; the other patient (case 2) is modified Rankin Scale 1 at 7-month follow-up.

Discussion

The management of tandem, acute vertebrobasilar occlusions is infrequently addressed in the literature. In a multicenter review of 28 patients treated for acute tandem occlusions, the majority (n = 25, 89%) were in the anterior circulation, while 3 were in the posterior circulation [5]. Details of the 3 posterior-circulation cases are limited, though 1 illustrative case demonstrated a near occlusive lesion in V2, representing a different class of lesion than that studied herein.

Yang et al. [6] described 7 cases of tandem vertebrobasilar occlusions treated through 6F guide catheters with stentrievers. While a different technique, it is interesting to note similar overall outcomes: no frank procedural complications, but 3/7 people expired as a result of the disease course despite successful recanalization. In this series, 4/7 patients had contralateral vertebral arteries ending in the posterior inferior cerebellar artery. This technique was similar to that reported by Ecker et al. [7] who describe revascularization of 6 tandem lesions with 2/6 patients ultimately expiring.

Our approach presents the feasibility of bringing a 6F sheath (Neuron MAX) into the V2 to allow for more effective and aggressive MAT with larger aspiration catheters. As noted in our 2 SHERPA cases, attempts with stentrievers/small aspiration catheters often prove fruitless from the nondominant/hypoplastic vertebral artery in contrast

to very effective aspiration achieved on a single pass or 2 passes with an 0.072-inch catheter.

Generally, 2 approaches can be applied for tandem lesions: an antegrade technique where the vessel is stented initially, or retrograde where the stent is placed at the conclusion of the procedure [1]. In these cases, the latter approach was used exclusively to allow for rapid reperfusion of the intracranial circulation without risk of stent dislodgment as a result of the antegrade passage of a large sheath into the vertebral artery. This approach also allows for the introduction of integrilin after intracranial work, which can be reassuring to the interventionalist, particularly in selected cases where patients had previously received tissue plasminogen activator. It is important to emphasize, however, that despite the absence of procedural complications, the disease course, particularly in patients presenting obtunded and with high NIHSS scores, continues to have a very guarded prognosis.

Conclusion

We present 2 techniques for the recanalization of tandem acute vertebrobasilar occlusions, both incumbent on the passage of a large sheath (Neuron MAX) into the V2 to allow for aggressive MAT. In the most straightforward approach, Dotter or balloon angioplasty of the ostium is performed, followed by thrombectomy and ostial stenting. In cases where the ostium cannot be easily visualized/crossed antegrade initially, if the contralateral vessel is hypoplastic, an exchange-length microwire can be used to delineate the location of the ostium, the SHERPA technique.

Disclosure Statement

B.T.J. is a consultant for Medtronic. T.G.J. is a consultant for Neuravi, Codman Neurovascular, Stryker (PI DAWN; unpaid), Fundacio Ictus (PI REVASCAT; unpaid), and holds stock in Anaconda, Silk Road, and Blockade.

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Author Contributions

Drafting of the article: B.A.G. Acquisition of data/data analysis: B.A.G. Review and revision of the article prior to submission: all authors. Study supervision: T.G.J.

References

1 Cohen JE, Leker RR, Gomori JM, Eichel R, Rajz G, Moscovici S, et al. Emergent revascularization of acute tandem vertebrobasilar occlusions: endovascular approaches and technical considerations-confirming the role of vertebral artery ostium stenosis as a cause of vertebrobasilar stroke. J Clin Neurosci. 2016 Dec;34:70–6.
2 Jankowitz B, Aghaebrahim A, Zirra A, Spataru O, Zaidi S, Jumaa M, et al. Manual aspiration thrombectomy: adjunctive endovascular recanalization technique in acute stroke interventions. Stroke. 2012 May;43(5):1408–11.

3 Jankowitz BT, Aleu A, Lin R, Jumaa M, Kanaan H, Kostov D, et al. Endovascular treatment of basilar artery occlusion by manual aspiration thrombectomy. J Neurointerv Surg. 2010 Jun;2(2):110–4.
4 Morales A, Parry PV, Jadhav A, Jovin T. A novel route of revascularization in basilar artery occlusion and review of the literature. J Neurointerv Surg. 2016 Jul;8(7):e25.
5 Puri AS, Kühn AL, Kwon HJ, Khan M, Hou SY, Lin E, et al. Endovascular treatment of tandem vascular occlusions in acute ischemic stroke. J Neurointerv Surg. 2015 Mar;7(3):158–63.
6 Yang H, Ma N, Zhang S, Huo X, Gao F, Sun X, et al. Endovascular revascularisation of acute tandem vertebrobasilar artery occlusion: seven case series with literature reviews. Stroke Vasc Neurol. 2018 Jan;3(1):17–21.
7 Ecker RD, Tsujiura CA, Baker CB, Cushing D. Endovascular reconstruction of vertebral artery occlusion prior to basilar thrombectomy in a series of six patients presenting with acute symptomatic basilar thrombosis. J Neurointerv Surg. 2014 Jun;6(5):379–83.