Original Paper

Functional Independence following Endovascular Treatment for Basilar Artery Occlusion despite Extensive Bilateral Pontine Infarcts on Diffusion-Weighted Imaging: Refuting a Self-Fulfilling Prophecy

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Key Words

Stroke · Basilar artery · Cerebrovascular occlusion · Diffusion MR imaging · Pons · Patient outcome assessment

Abstract

Background and Purpose: Extensive brainstem diffusion-weighted imaging (DWI) hyperintensity has been associated with poor outcomes. We aim at documenting a series of patients with extensive DWI pontine lesions who achieved independence following endovascular therapy and aggressive medical therapy in the setting of posterior circulation basilar artery occlusion (BAO). **Methods:** This is a retrospective endovascular database review of a single-operator experience over a 9-year period for patients with (1) complete BAO, (2) extensive bilateral pontine DWI changes and (3) 90-day modified Rankin scale 0–2. **Results:** Three out of a total of 40 patients met the inclusion criteria. Case 1 was an 18-year-old male with National Institutes of Health Stroke Scale (NIHSS) 32 on admission, treated 25 h after symptom onset. Case 2 was a 56-year-old male with NIHSS 19, treated 10 h after onset. Case 3 was a 73-year-old male with NIHSS 29, treated 6 h after onset. Full endovascular reperfusion was achieved in all 3 patients. A literature review identified 9 additional cases of extensive pontine DWI changes and good outcome. These patients were young (32 ± 22 years), mostly males (69%), presented with a relatively low posterior circulation Acute Stroke Prognosis Early CT Score (6 ± 1), were treated relatively late from last known normal (13 ± 10 h) and were mostly (84%) treated with endovascular intervention. **Conclusion:** Extensive bilateral pontine DWI lesions among patients with BAO are not an unequivocal indicator of poor prognosis. We advise strong caution when considering these findings in the treatment decision algorithm.

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Introduction

Acute basilar artery occlusion (BAO) carries high morbidity and mortality [1]. Diffusion-weighted imaging (DWI) has become the gold standard for the evaluation of the presence and extent of ischemic stroke, and it is particularly important for the evaluation of posterior fossa parenchyma in stroke. Patients presenting with extensive brainstem changes on pretreatment DWI are often excluded from endovascular therapy due to their predicted poor outcome [2]. We aim at documenting a series of patients with extensive bilateral DWI pontine lesions on post-treatment MRI who achieved functional independence following endovascular therapy and aggressive medical therapy in the setting of complete BAO.

Methods

This was a retrospective endovascular database review of a single-operator experience over a 9-year period performed to identify patients fulfilling the following criteria: (1) complete BAO, (2) extensive bilateral pontine DWI changes on post-treatment MRI and (3) 90-day modified Rankin scale (mRS) 0–2. Descriptive analysis of clinical, procedural and imaging findings is provided. BAO was classified into proximal (confluence of vertebral arteries to the takeoff of the anterior inferior cerebellar arteries), mid-basilar (from the anterior inferior cerebellar arteries to the origin of the superior cerebellar arteries) or distal (superior cerebellar arteries and distal) [3]. Stroke severity was assessed with the National Institutes of Health Stroke Scale (NIHSS). For the pediatric cases found in the literature, the Pediatric NIHSS was used [4]. This study was approved by the local institutional review boards.

A PubMed literature search was performed for the identification of all published reports that described patients with extensive bilateral pontine DWI hyperintensities and good clinical outcome from January 1996 to March 2016. Search terms included ‘DWI’, ‘reversibility’, ‘basilar artery occlusion’, ‘thrombectomy’, ‘thrombolysis’, ‘pons’, ‘brainstem’. All articles in English encompassing retrospective or prospective studies were screened and subsequently evaluated for eligibility and inclusion.

Results

Three out of total 40 patients with acute ischemic stroke from BAO met our inclusion criteria. All patients had pre- or post-treatment MRI with DWI, had BAOs and were treated with mechanical thrombectomy resulting in complete (thrombolysis in cerebral infarction; TICI 3) reperfusion.

Case 1

Case 1 was an 18-year-old male without past medical history who developed acute paraparesis and right-hand clumsiness progressing to anarthria, obtundation and extensor posturing. Brain MRI demonstrated extensive areas of DWI restriction involving the bilateral rostral basis pontis (fig. 1a); the fluid-attenuated inversion recovery (FLAIR) sequence revealed very subtle hyperintensity in the pons. The preprocedural NIHSS was 24, and the time from onset to puncture was 25 h. Conventional angiography confirmed a basilar occlusion immediately past the origin of the anterior inferior cerebellar artery (fig. 1a). One pass of the Merci retriever partially recanalized with a residual right posterior cerebral artery occlusion treated with Penumbra 041 thromboaspiration resulting in full (TICI 3) reperfusion. Brain MRI performed 1 day after treatment showed reversibility of a large proportion of the DWI hyperintensity; however, significant FLAIR signal changes in the bilateral pons (fig. 1a) were still present. Workup was remarkable for a patent foramen ovale that was subsequently closed. At 90 days, NIHSS and mRS were 0.

Fig. 1. MR and mechanical thrombectomy imaging of the reported cases. **a** Case 1. **b** Case 2. **c** Case 3. MRI DWI showing different pontine levels (left) and pre- and postfrontal angiography (right).

Case 2

Case 2 was a 56-year-old male patient with a history of hypertension, alcohol and tobacco abuse who presented with acute anarthria, right facial droop and right-sided weakness at an outside hospital. NIHSS was 19, CT angiography showed a BAO and the time interval from onset to puncture was 10 h. Angiography confirmed a BAO immediately past the origin of the anterior inferior cerebellar artery (fig. 1b). One pass of stent retriever thrombectomy led to reperfusion and exposed an underlying atherosclerotic plaque with 70% stenosis. Balloon-mounted stenting was performed, leading to complete reperfusion (TICI 3). Brain DWI after 24 h showed multifocal acute infarctions involving the bilateral cerebellum, right middle cerebellar peduncle, central pons (left greater than right), right pontomesencephalic and right midbrain, as well as the splenium of the right corpus callosum (fig. 1b); FLAIR revealed hyperintensity within the aforementioned pontine lesion. The patient was discharged from the hospital after 7 days with a NIHSS of 4. His NIHSS was 2 and mRS was 1 at 90 days of follow-up.

Case 3

Case 3 was a 73-year-old male with a past medical history of hypertension who had a wake-up stroke last seen normal 6 h before. He was found lethargic, anarthric, with left hemi-

Table 1. Summary of the reported cases of BAO with extensive DWI pontine hyperintensities and good outcome

First author [ref.]	Year	Case	Age, years	Sex	NIHSS	pc-ASPECTS	Occlusion site	Etiology	Therapy	Time from onset to therapy, h	TICI	90-day mRS
Current study	2016	1	18	M	32	5	Mid	PFO	IAT	25	TICI 3	0
Current study	2016	2	56	M	19	4	Mid	ICAD	IAT	10	TICI 3	1
Current study	2016	3	73	F	29	4	Proximal	ICAD	IAT	6	TICI 3	2
Ladner [5]	2014	4	5	M	22 ^a	6	Mid	Dissection	IAT	9	TICI 2b	0
Bodey [6]	2014	5	10	M	27 ^a	7	Distal	Dissection	IAT	36	–	3 ^b
		6	6	M	28 ^a	8	–	Dissection	IAT	–	–	0 ^b
Yoo [7]	2010	7	67	F	31	8	Mid	–	IAT	8	–	0
Samaniego [8]	2009	8	32	M	25	8	–	Dissection	IV tPA	–	–	0
		9	16	M	35	6	–	Dissection	IAT	20	–	0
		10	30	F	–	6	–	–	IV tPA	–	–	2
Alderazi [10]	2014	11	41	M	12	6	Proximal	PFO	IAT	5.5	TICI 3	0
Tomycz [9]	2008	12	46	M	–	5	Mid	Athero-thrombotic	IAT	11	TIMI 2	1
		13	27	F	–	7	Proximal	Dissection	IAT	7	TIMI 2	1

PFO = Patent foramen ovale; pc-ASPECTS = posterior circulation Acute Stroke Prognosis Early CT Score; ICAD = intracranial atherosclerotic disease; IV tPA = intravenous tissue plasminogen activator; IAT = intra-arterial therapy; TIMI = thrombolysis in myocardial ischemia. ^a Pediatric NIHSS. ^b mRS for children.

plegia and was taken to an outside hospital and was intubated. NIHSS was 29, and CT angiography revealed intracranial left vertebral artery occlusion with extension into the basilar artery. Upon arrival, head CT showed a hyperdense basilar artery and patchy hypodense areas in the cerebellum. The time from last normal to puncture was 6 h. Angiography confirmed a left vertebral V4 occlusion immediately after the origin of the posterior inferior cerebellar artery (fig. 1c), and stent retriever thrombectomy with local thromboaspiration led to recanalization, revealing high-grade mid-basilar stenosis. This was followed by balloon angioplasty of the basilar and thromboaspiration of the left posterior cerebellar artery. NIHSS at 24 h was 4. DWI of the brain 5 days after thrombectomy revealed bilateral DWI hyperintensity (fig. 1c) and correspondent hyperintensity on FLAIR. The hospital course was complicated and prolonged by aspiration pneumonia. The patient was discharged from the hospital after 3 weeks to a long-term acute care facility still on mechanical ventilation via tracheostomy. However, clinical evaluation at 90 days demonstrated nearly no residual deficits with a NIHSS = 1 and mRS = 2.

The literature review has identified additional 9 cases of extensive pontine DWI changes and good outcome (table 1) [5–10]. The patients were young (32 ± 22 years), mostly males (69%), presented with a low posterior circulation Acute Stroke Prognosis Early CT Score (6 ± 1), were treated relatively late from last known normal (13 ± 10 h) and were mostly (84%) treated with endovascular intervention.

Discussion

The present series corroborate the previous suggestion that extensive DWI changes do not constitute an absolute marker of poor outcome and should not be used to automatically exclude patients from reperfusion therapies.

Many studies had shown that early DWI lesions on the pontine region represent an independent predictor of poor outcomes [2, 11–13]. Results from a study of 29 patients revealed

that a higher brain stem 22-point semiquantitative DWI lesion score was the only independent baseline predictor for clinical outcome [2]. An association between >10-point semiquantitative DWI score at baseline and poorer outcome or death (mRS ≥ 3) has been reported in another study of 16 individuals [14]. A 31-patient study of patients with BAO indicated that more extensive DWI brainstem load on a 12-point semi-quantitative scoring system was highly predictive of poor clinical outcome [15].

Our findings reinforce previously published reports and indicate that extensive pontine DWI changes do not constitute an unequivocal sign of poor outcome [5–9]. The pooled documented cases of good outcome despite extensive pontine DWI changes indicate that this phenomenon occurred more often in young patients who were typically treated endovascularly and was observed even with a late presentation from last known normal to puncture.

Brainstem DWI hyperintensity can undergo diffusion normalization following successful treatment of BAO [7, 16]. DWI reversibility has been reported to be commonly transient, has been demonstrated not to correlate with early reperfusion and not to independently predict good outcomes [17]. It is unclear if DWI lesions of the brain stem behave differently from anterior circulation infarcts [14]. However, the findings reported in this series indicate that regardless of its radiological reversibility, DWI changes are not a definite indicator of poor prognosis. The reported cases highlight the potential role of reperfusion among patients with extensive involvement of basilar artery.

Conclusion

Extensive bilateral pontine DWI lesions among patients with BAO are not an unequivocal indicator of poor prognosis. This occurrence has been reported in relatively young patients more commonly reperfused endovascularly. We advise strong caution when considering these findings in the treatment decision algorithm.

Disclosure Statement

D.C.H., R.A.C.O., and V.P. have no conflicts of interest to disclose. R.G.N. has the following disclosures: Stryker Neurovascular (Trepo-2 Trial PI, DAWN Trial PI), Covidien (SWIFT and SWIFT-PRIME Steering Committee, STAR Trial Core Lab) and Penumbra (3-D Separator Trial Executive Committee).

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