

## A low score on the National Institutes of Health Stroke Scale with eye movement disorder may indicate a good candidate for acute mechanical thrombectomy for posterior circulation large vessel occlusion: illustrative cases

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**BACKGROUND** Basilar artery occlusion (BAO) accounts for 1% of all strokes, and its natural prognosis is extremely poor. There is no consensus on the treatment strategy for mild BAO.

**OBSERVATIONS** Between August 2015 and May 2021, 429 patients received mechanical thrombectomy (MT) in the authors' hospital. Three patients had a BAO with a National Institutes of Health Stroke Scale (NIHSS) score of  $\leq 6$  and showed eye movement disorder as the main symptom. MT immediately improved ocular symptoms in all three cases, and the patients were discharged with a modified Rankin Scale  $\leq 2$ .

**LESSONS** Lesions responsible for the eye movement disorder are distributed from the midbrain to the pontine tegmentum. These lesions are supplied by the arteries of the interpeduncular fossa, which is impaired by BAO. Symptoms due to problems with the arteries of the interpeduncular fossa can be rapidly improved by MT, and it is useful for preventing neurological deterioration in mild cases. BAO with a low NIHSS score in the presence of eye movement disorder as the main symptom may be a good indication for MT.

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**KEYWORDS** acute ischemic stroke; basilar artery occlusion; mechanical thrombectomy

Basilar artery occlusion (BAO) accounts for 1% of all strokes, and its natural prognosis is extremely poor.<sup>1</sup> There is no consensus on the treatment strategy for mild cases of BAO.

Evidence of mechanical thrombectomy (MT) for large vessel occlusion of the anterior circulation was established in HERMES,<sup>2</sup> which is an integrated analysis of five randomized controlled trials. The DEFUSE 3<sup>3</sup> (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3) and DAWN<sup>4</sup> (Diffusion Weighted Imaging [DWI] or Computerized Tomography Perfusion [CTP] Assessment With Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention) trials

demonstrated the conditional efficacy of MT in patients 6 hours after the onset of symptoms. However, the efficacy of MT for BAO has not been proven. It is important to accumulate evidence supporting its treatment efficacy.

A total of 429 patients received MT between August 2015 and May 2021 at our institution. Of these patients, 35 (8.1%) cases were diagnosed with BAO. Four patients had a National Institutes of Health Stroke Scale (NIHSS) score of  $\leq 6$ ; of those patients, three (0.6%) had eye movement disorder as the main symptom. Here, we describe these three cases and the treatment efficacy of MT in these cases.

**ABBREVIATIONS** BAO = basilar artery occlusion; DSA = digital subtraction angiography; DWI = diffusion-weighted imaging; INO = internuclear ophthalmoplegia; MRA = magnetic resonance angiography; MRI = magnetic resonance imaging; mRS = modified Rankin Scale; MT = mechanical thrombectomy; NIHSS = National Institutes of Health Stroke Scale; PCA = posterior cerebral artery; Pcom = posterior communicating artery; PPRF = paramedian pontine reticular formation; TICI = thrombolysis in cerebral infarction.

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## Illustrative Cases

### Case 1

A 64-year-old man with a history of alcoholism and hypertension presented at the emergency department 13 hours, 15 minutes after the onset of one-and-a-half syndrome and ataxia of the four limbs. The patient had an NIHSS score of 6. Magnetic resonance imaging (MRI) showed bilateral high-intensity areas at the pons on diffusion-weighted imaging (DWI). MR angiography (MRA) revealed BAO (Fig. 1A). Bilateral posterior cerebral arteries (PCAs) were maintained by the posterior communicating artery (Pcom). Digital subtraction angiography (DSA) showed BAO (Fig. 1B and C). Through an 8-Fr Roadmaster guide catheter (Goodman), a coaxial system consisting of a SOFIAFLOW plus catheter (Terumo) and a Headway21 microcatheter (Terumo) was used to approach the occlusion site. Using a 4 × 40-mm Tron FXII stent retriever (Terumo), the combined technique was performed two times. Follow-up DSA demonstrated recanalization of thrombolysis in cerebral infarction (TICI) 3 310 minutes after the onset of symptoms (Fig. 1D and E). Immediately after MT, dysarthria improved, and one-and-a-half syndrome converted to left internuclear ophthalmoplegia (INO). MRI showed bilateral infarction in the upper part of the pons (Fig. 1F). After admission, paroxysmal atrial fibrillation was observed, and a diagnosis of a cardioembolic stroke was established. As secondary prophylaxis, edoxaban 30 mg/day, was administered. The patient was transferred to the hospital for rehabilitation on day 15 with an NIHSS score of 2, a modified Rankin Scale (mRS) score of 2, mild left INO, and residual cerebellar ataxia in the left upper limb.

### Case 2

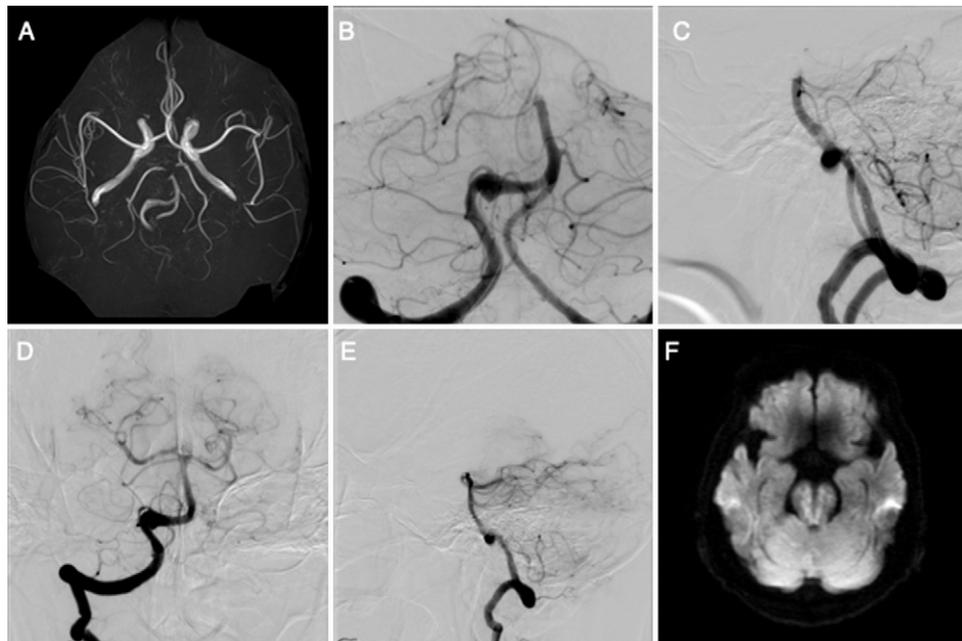
A 58-year-old woman with diabetes and hypertension presented 50 minutes after the onset of dizziness, left oculomotor nerve palsy, and ataxia of the left upper limb. She had an NIHSS score of 3. MRI showed a high-intensity area in the left cerebellum on DWI,

and MRA showed BAO (Fig. 2A). Intravenous alteplase was administered while preparations were being made for MT, but her symptoms did not improve. DSA showed a thrombus in the right PCA to the tip of the basilar artery (Fig. 2B and C). Through an 8-Fr Roadmaster guide catheter, MT was performed with one pass of the coaxial system of a Penumbra 5 MAX ACE 60 catheter (Penumbra Inc.) and a Marksman catheter (Medtronic), using a direct aspiration first pass technique, resulting in TICI 3 reperfusion 362 minutes after the onset of symptoms (Fig. 2D and E). Symptoms disappeared immediately after MT, and the NIHSS score improved to 0. MRI showed no ischemic lesion (Fig. 2F). On day 2, transthoracic echocardiography revealed a mobile tumor in the left atrium, which was removed on day 4. A diagnosis of cardiac myxoma was established. The patient was discharged home on day 25 with an NIHSS score of 0 and an mRS of 0.

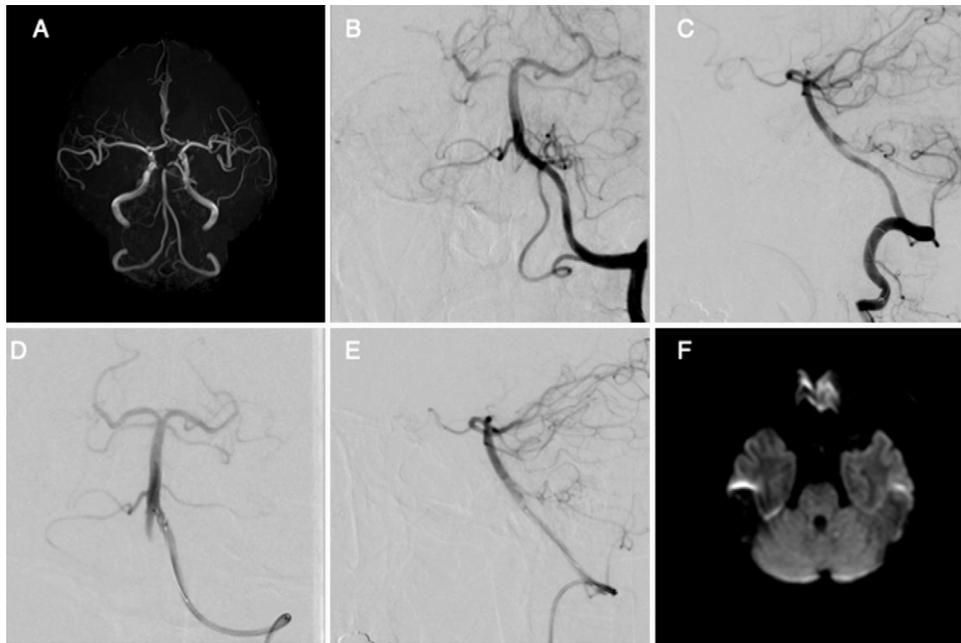
### Case 3

A 34-year-old woman with hypertension developed a transient right-sided numbness. Three days later, she presented with dizziness and ataxia of the left upper limb, with an NIHSS score of 1. Head MRI showed a high-intensity area in the right posterior inferior cerebellar artery region on DWI. MRA showed occlusion of the left vertebral artery (Fig. 3A and B). The patient was treated with 10,000 units of heparin/day.

The patient's symptoms improved after admission, but on day 11, she presented with skew deviation and left one-and-a-half syndrome, with an NIHSS score of 2. MRI showed no new high-intensity area on DWI, and MRA showed BAO (Fig. 3C). DSA showed a thrombus on the basilar tip (Fig. 3D and E). Through an 8-Fr FUBUKI guide catheter (Asahi Intecc), MT was performed with one pass of the coaxial system of a Penumbra 5 MAX ACE 60 catheter and a Marksman catheter, using a direct aspiration first pass technique, resulting in TICI



**FIG. 1.** Case 1. MRA (A) on admission showing BAO. Frontal (B) and lateral (C) views of DSA confirming the BAO. Follow-up DSA (D and E) after thrombectomy showing recanalization of the basilar artery. Follow-up DWI (F) showing bilateral infarction of the pons.



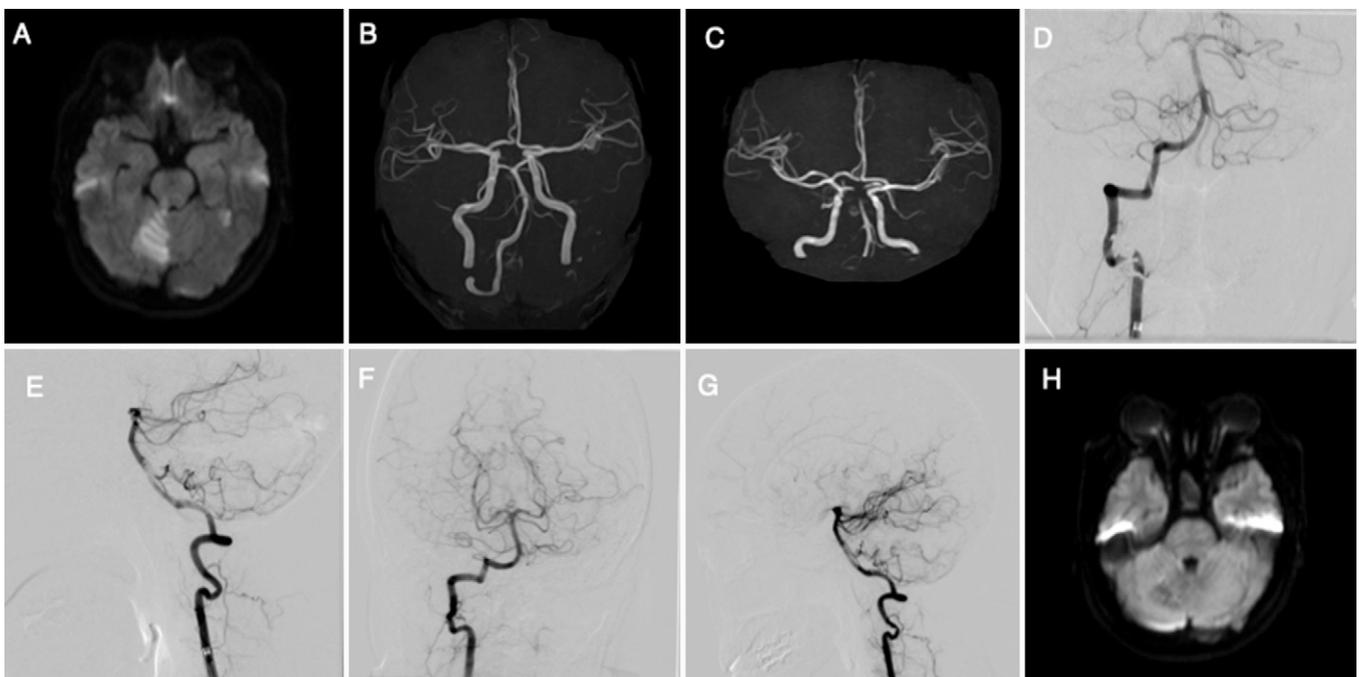
**FIG. 2.** Case 2. MRA (A) on admission showing BAO. Frontal (B) and lateral (C) views of DSA confirming the thrombus in the right PCA to the tip of the basilar artery. Follow-up DSA (D and E) after thrombectomy showing recanalization of the basilar artery. Follow-up MRI (F) showing no infarction.

3 reperfusion 169 minutes after the onset of symptoms (Fig. 3F and G). The patient's symptoms improved immediately after the MT. MRI showed no ischemic lesion (Fig. 3H). The patient was suspected to have left vertebral artery dissection and was treated with aspirin 100 mg/day as secondary prophylaxis. She was discharged home with an NIHSS score of 0 and mRS score of 0.

## Discussion

### Observations

The BEST<sup>5</sup> (Acute Basilar Artery Occlusion: Endovascular Interventions vs Standard Medical Treatment) and BASICS<sup>6</sup> (Basilar Artery International Cooperation Study) trials failed to show the efficacy of MT for BAO. There is no consensus on the indication of MT for mild cases of



**FIG. 3.** Case 3. DWI MRI (A) showing a high-intensity area on the right cerebellum. MRA (B and C) on admission showing occlusion of the left vertebral artery. Frontal (D) and lateral (E) views of DSA confirming the thrombus on the tip of basilar artery. Follow-up DSA (F and G) after thrombectomy showing recanalization of the basilar artery. Follow-up MRI (H) showing no new infarction.

BAO. Guenego et al. retrospectively reported that MT was safe and effective for BAO with NIHSS score  $\leq 6$ , with high rates of recanalization.<sup>7</sup>

In our case series, only 0.6% of patients who received thrombectomy had mild cases of BAO that presented with eye movement disorder. All three patients showed improvement in ocular symptoms immediately after MT, and their mRS at discharge was  $< 2$ , which was a good result.

The patients in Cases 1 and 3 presented with one-and-a-half syndrome. One-and-a-half syndrome, which was proposed by Fisher in 1967, is a combination of unilateral horizontal oculomotor impairment and INO.<sup>8</sup> Wall and Wray suggested that in addition to a lesion of the contralateral median longitudinal fasciculus, there are four lesions that cause one-and-a-half syndrome: lesions of the ipsilateral paramedian pontine reticular formation (PPRF), ipsilateral abducens nucleus, ipsilateral PPRF and the abducens nerve nucleus, and motoneuron root fibers of the ipsilateral abducens nucleus to the lateral rectus.<sup>9</sup> Because these areas are located in the pontine tegmentum, the arteries supplying this region are important. Duvernoy proposed that in addition to the median and paramedian pontine perforating arteries, the descending branches of the arteries of the interpeduncular fossa in the upper part of the bridge and the descending branches of the arteries of the foramen cecum in the lower part of the pons are important arteries for the pontine tegmentum.<sup>10</sup> Usually, occlusion of the median and paramedian pontine perforating artery does not impair the pontine tegmentum,<sup>11</sup> but occlusion of the basilar artery tip causes simultaneous disruption of blood flow in the arteries of the interpeduncular fossa, PCA, and superior cerebellar artery, leading to ischemia of the midbrain and pontine tegmentum, thereby causing eye movement disorder.

In Case 1, there was improvement from left one-and-a-half syndrome to left INO, which may have been because of improvement in the left PPRF or abducens nucleus function. This was the result of enhanced blood flow in the pontine tegmentum caused by the recanalization of the left superior cerebellar artery and arteries of the interpeduncular fossa. Although more than 13 hours had passed since the patient was last known well, he experienced relatively mild symptoms, which may have been because of collateral circulation from the bilateral Pcoms and PCA. Case 2 involved palsy of the left oculomotor nerve. Although the left Pcom was present and perfusion was maintained in the PCA region, ischemic symptoms occurred in the midbrain tegmentum due to occlusion of the basilar artery tip. In Case 3, similar to Case 1, left one-and-a-half syndrome was present, but the short time from onset and the presence of bilateral Pcom were regarded to be related to the mild symptoms.

There are few reports on the prognosis of eye movement disorder due to brainstem infarction. Kim reported 30 cases of INO due to brainstem infarction;<sup>12</sup> all 30 patients improved within 1 day to 12 months, suggesting that the natural course of INO due to brainstem infarction may be favorable. However, only one case of BAO was noted.

BAO generally presents with severe symptoms; however, all three cases in our report involved mild symptoms, with the predominance of eye movement disorder. Raymond et al. reported that most patients with BAO who had NIHSS  $\leq 10$  had a good prognosis without MT. However, 12 of the 32 patients in their study had neurological deterioration after admission, and 4 patients had a poor prognosis despite MT.<sup>13</sup> The authors suggested that conservative treatment should be prioritized for patients with mild BAO; however, worsening symptoms indicate an extremely poor disease course.

## Lessons

Our study suggests that MT may provide remarkable improvement in patients with mild BAO, whose main symptom is eye movement disorder. Mild BAO in which eye movement disorder is the main symptom may be a good indication for MT.

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## Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

## Author Contributions

Conception and design: Kimura, Yamazaki, Doijiri, Oi, Yokosawa, Kikuchi. Acquisition of data: Kimura, Yamazaki, Doijiri, Takikawa, Sonoda, Oi. Analysis and interpretation of data: Kimura, Yamazaki, Doijiri, Oi. Drafting the article: Kimura, Yamazaki, Doijiri, Oi, Yokosawa. Critically revising the article: Kimura, Oi. Reviewed submitted version of manuscript: Kimura, Yamazaki, Oi, Uchida, Sugawara. Approved the final version of the manuscript on behalf of all authors: Kimura. Statistical analysis: Oi. Administrative/technical/material support: Kimura, Oi. Study supervision: Yamazaki, Oi.

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