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Favorable outcome from a locked-in state despite extensive pontine infarction by MRI

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Abstract

Introduction—Outcome prediction of patients who are in a locked-in state is challenging. Extensive pontine infarction on diffusion weighted imaging MRI (DWI) has been proposed as a poor prognosticator. We report on three patients with a locked-in state with unexpected favorable recoveries despite DWI evidence of widespread pontine ischemia.

Methods—Report of three cases.

Results—Three young patients (32, 30 and 16 years old) presented with a locked-in state caused by pontine infarction. The first patient did not receive any acute stroke therapies, the second patient underwent endovascular therapy 20 hours after symptom onset resulting in partial recanalization of the basilar artery, and the third patient progressed to a locked-in state despite having received intravenous tissue plasminogen activator. The DWI of all three patients demonstrated acute and widespread pontine infarction involving more than two-thirds of the pons. Two patients regained full independence in their activities of daily living. The third patient remained wheelchair bound, but lives with her family, eats independently, uses a typewriter and wrote a book.

Conclusion—Patients who are in a locked-in state may have substantial functional recovery despite DWI evidence of extensive pontine infarction.

Search Terms

Cerebrovascular disease; stroke; infarction; DWI; locked-in

Introduction

Locked-in state is caused by an insult to the ventral pons (basis pontis). It is characterized by anarthria and quadriplegia, with preservation of consciousness. Patients retain vertical eye movement, facilitating non-verbal communication.[1] The lesion essentially interrupts corticobulbar and corticospinal pathways, somatosensory and ascending neuronal pathways responsible for arousal and wakefulness remain intact. It is challenging to predict functional

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outcome in patients with a recent diagnosis of a locked-in state caused by brainstem ischemia. Small diffusion-weighted magnetic resonance imaging (DWI) lesions have a potentially favorable outcome if reperfusion is achieved rapidly, however, larger brain stem DWI lesions are predictive of poor outcome.[2] A study using a DWI lesion scoring system showed in multivariate regression analysis that the extent of brain stem DWI lesion was the strongest baseline predictor of outcome.[3] We describe three patients with a locked-in state and a much more favorable outcome than we anticipated in spite of DWI evidence of acute pontine infarction involving more than two-thirds of the pons.

Case # 1

A 32 year-old professional wrestler suddenly developed blurred vision, dysarthria and left hemiparesis. Over the next two days his neurological deficits progressed to a complete locked-in state. He was awake, alert and quadriplegic. He required mechanical ventilation for airway protection and his blood pressure was elevated. He did not have horizontal eye movements, vertical eye movements were present and he was able to blink in order to communicate with others. Pupils were 4 mm in diameter, equal and reactive to light. Face and tongue movements were absent. He was able to feel pain and touch in the face and all four extremities. Brain DWI and magnetic resonance angiography (MRA) demonstrated extensive bilateral infarction of the basis pontis and upper medulla (figure, A), and occlusion of the basilar artery. The right vertebral artery was also occluded, which was felt to be most likely due to a vertebral artery dissection. He was treated with full dose intravenous anticoagulation. He remained in a complete locked-in state for one week after which he developed minimal movement of finger flexors in his right hand. Two weeks later he was able to lift his right arm and leg against gravity. However, he continued to have left sided hemiplegia. He required a tracheostomy and a gastrostomy tube placement prior to discharge to a rehabilitation facility. He received aggressive rehabilitation and was treated with warfarin for three months after which he was switched to aspirin therapy. Two years later he continued to be dysarthric and clumsy, but he was ambulating and driving without assistance, performed all activities of daily living independently and had started an internet-based business.

Case # 2

A 16 year-old football player collapsed minutes after a head-to-head collision during one of his games. He was lethargic, vomited and had intermittent jerking of all four extremities. He was hypertensive and required intubation for airway protection. On his initial neurological examination, he was unresponsive, corneal and oculocephalic reflexes were absent. Pupils were 4 mm in diameter, equal, round and reactive to light. With painful stimulation over his chest, he had flexor posturing of his upper and extensor posturing of his lower extremities. DWI and MRA showed bilateral pontine and upper medulla infarctions (figure, B), occlusion of the basilar artery and a left vertebral artery dissection. Endovascular treatment was performed 20 hours after symptom onset and resulted in partial recanalization of the basilar artery. He was anticoagulated intravenously and switched to daily aspirin by the time of hospital discharge. After the endovascular procedure he was awake, but remained in a complete locked-in state for a week. After three weeks he was able to squeeze with his right hand and wiggle his toes bilaterally. With intense rehabilitation he made steady improvements. Six months after his initial presentation his speech was fluent and his cranial nerve examination was normal. He had mild concentration problems and a pseudobulbar affect, but had returned back to school.

Case # 3

A 30 year-old woman developed acute right facial weakness and left hemiparesis. She received intravenous tissue plasminogen activator with mild symptom improvement; however, within the next 12 hours her hemiparesis worsened and she progressed to a complete locked-in state. She was hypertensive and for airway protection required intubation and mechanical ventilation. DWI and MRA revealed near complete pontine infarction (figure, C) and a basilar artery occlusion. A detailed diagnostic work-up for the cause of her stroke was unrevealing. She required prolonged mechanical ventilation since remained in a complete locked-in state for a month after which she started to move one of her thumbs. Three years later, she continues to require assistance with daily living, has dysarthria and a pseudobulbar affect. However, her tracheostomy and gastrostomy tubes have been removed, she is able to eat, move her limbs, use a typewriter, and transport in her wheelchair independently. She lives at home with her family and children, maintains her own website and has written a book.

Discussion

The locked-in syndrome, described by Plum and Posner in 1969 [4], often leads to a severely disabled state or death.[5] However, there have been several reports of patients with substantial clinical improvement.[6,7] The mechanisms for late improvement remain poorly understood. Formation of collateral circulation, neuronal regeneration, and remyelination may each play a role.[8] It is difficult to predict in the acute phase which patients are most likely to improve.

Clinical predictors that have been associated with a favorable outcome are young age, absence of hypertension, and a history of vertebrobasilar insufficiency.[9] Aggressive early rehabilitation may also be important.[5,7] Furthermore, the prognosis of the locked-in state may also be influenced by the underlying cause. One study reported improved survival and recovery rates in patients with non-vascular etiologies such as trauma, central pontine myelinolysis, tumors and encephalitis.[10]

Modern imaging technology, specifically DWI evidence of severe pontine infarction, has been proposed as an indicator of poor clinical outcome.[2,3] We present three patients with a complete locked-in syndrome who had unexpected favorable recoveries despite very extensive bilateral pontine infarction on DWI. As suggested by Kidwell and colleagues, DWI lesions do not invariably represent irreversible injury, furthermore, ischemic penumbra may include not only areas of diffusion/perfusion mismatch, but also portions within diffusion abnormality itself.[11] All three patients were young which may have played an important role in their recovery. The first two patients experienced dramatic neurological improvements in the first 2 to 3 months, while the last patient had a more modest and delayed recovery.

Our patients illustrate that despite DWI evidence of acute and very severe pontine infarction, patients with a locked-in state can experience substantial clinical improvements. Therefore, we believe that caution should be exercised when using DWI to assist with prognostication of these patients and with decision making on whether or not to pursue aggressive supportive measures.

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Figure.
Diffusion-weighted imaging of the pons of case 1 (panel A), case 2 (panel B) and case 3 (panel C) showing acute and severe pontine infarction involving more than two-thirds of the pons.