Reversal sign: a red-flag in emergency departments

Sabina Bhoil and Rohit Bhoil explain the significance of a finding from brain scans that indicates inversion of the normal relationship between grey and white matter.

Abstract

The reversal sign is an ominous finding seen on computed tomographic images of the brain as an inversion of the normal attenuation relationship between grey and white matter. This article describes the pathophysiology of the reversal sign, which indicates irreversible neural tissue damage, and includes a brief case study of a child who drowned and later developed this sign. The child died two hours after presenting to the emergency department. Emergency healthcare professionals should be aware of this sign, which is significant in terms of diagnosis, management and prognosis. Knowledge of the reversal sign will also help emergency nurses support relatives who are about to be notified about the possible long-term neurological deficits in, or death of, their loved one.

Keywords

brain injury, neurological deficit, computed tomography, white cerebellar sign, dense cerebellum sign, drowning, emergency care

THE BRAIN surface is formed by folds of the cerebral cortex known as gyri (singular: gyrus) between which lie furrows called sulci, which contain cerebrospinal fluid (Figure 1). The inner two layers enveloping the brain, known as arachnoid and pia mater, separate at places to produce cisterns, or cisternal spaces, that are filled with cerebrospinal fluid.

This article draws on a case study in which a four-year-old boy with altered consciousness had been taken by his parents to an emergency department (ED). His parents reported that he had fallen into a pool while playing and had lain under the water unattended for between one and two minutes.

On examination the boy was found to have a Glasgow Coma Scale score of 8, and generalised tonic-clonic seizures, which had developed after an episode of drowning three hours earlier. There was a history of three episodes of vomiting and, at the time of presentation, the child had neck rigidity and papilloedema on fundoscopic examination, all of which suggested raised intracranial pressure.

An urgent non-contrast computed tomographic (CT) scan of the boy’s brain was undertaken and revealed that the bilateral cerebral hemispheres were diffusely of low attenuation with effaced cisternal and sulcal spaces (Figure 2).

The thalami and the cerebellum were of normal attenuation, but appeared hyperdense or ‘white’ relative to the cerebral parenchyma.

These findings suggested that the boy had suffered irreversible hypoxic brain injury. Sadly, he died two hours after he had presented to the ED.
Reversal sign

Reversal sign seen on CT images represents a generalised decrease in the density (attenuation) of cerebral hemispheres, with loss of the normal grey-white differentiation and increased attenuation of the thalami, brainstem and cerebellum. It is also known as the white cerebellum or dense cerebellum sign because of its appearance (Cook 2004, Chalela et al 2013, Krishnan and Chowdhury 2014).

The reversal sign indicates a diffuse cerebral injury in patients who have suffered an ischaemic/anoxic insult, and can be seen on the CT scans of patients with conditions such as birth asphyxia, head trauma, status epilepticus, drowning, strangulation, infection and/or inflammation of the brain and its meninges, hypothermia and other causes of global cerebral ischaemia (Cook 2004, Huisman et al 2007).

Many mechanisms to explain the peculiar appearance of the reversal sign have been proposed, but the most accepted is that preserved blood flow to the posterior circulation, compared with the anterior circulation, maintains the normal, ‘brighter’ appearance of the cerebellum compared with the ‘darker’ cerebrum (Chalela et al 2013). Post-ischaemic hypervascularity may cause the relatively increased attenuation seen in the thalami and basal ganglia.

Other possible mechanisms include distension of the medullary veins secondary to incomplete obstruction of venous outflow due to raised intracranial tension, increased post-ischaemic hypervascularity, and transtentorial herniation, seen in increased intracranial pressure, leading to improved perfusion and therefore increased attenuation of the central structures such as the brain-stem (Cook 2004, Huisman et al 2007, Chalela et al 2013, Krishnan and Chowdhury 2014).

The presence of reversal sign indicates irreversible neural tissue damage and is associated with poor prognosis. Children who display the reversal sign on CT images have a high mortality rate (35%), and there is an increased incidence of profound neurological deficit with developmental delays in those who survive (Kavanagh 2007).

Conclusion

Emergency clinicians should be aware of this sign, which is significant from a diagnostic, therapeutic and prognostic point of view, and nurses should understand that imminent death of the patient is likely and try to sensitively prepare families for this.

References


