Brain involvement in haemolytic-uraemic syndrome: MRI features of coagulative necrosis

Abstract We describe radiological demonstration of brain involvement in haemolytic-uraemic syndrome (HUS) in two siblings with a very different clinical course. While the brother presented with a mild, reversible encephalopathy, his sister developed high-signal lesions in the cortex, putamen and caudate nucleus on T1-weighted images, seen as dense areas on CT. Biopsy revealed coagulative necrosis due to microthrombosis without haemorrhage, calcification or infection. These findings suggest a possible prognostic role for MRI in cases of encephalopathy due to HUS.

Keywords Haemolytic-uraemic syndrome · Cortical laminar necrosis · Magnetic resonance imaging · Computed tomography

Introduction

Mainly affecting children with bacterial gastroenteritis or upper respiratory tract infection, the haemolytic-uraemic syndrome (HUS) is defined as a multiorgan disease characterised by the triad of microangiopathic haemolytic anaemia, thrombocytopenia and uraemia [1, 2, 3]. It is the most common cause of acute renal failure in children. Its overall prognosis has been improved by progress in dialysis. However, once extrarenal manifestations occur, prognosis worsens considerably [2, 3]. Involvement of multiple organs has been documented, the central nervous system being by far the most common, in 20–50% of cases [1, 3].

There have been several reports of involvement of deep grey-matter structures, the basal ganglia and the thalamus [1, 2, 4, 5, 6]. Extensive cortical lesions have not, however, been demonstrated on MRI. We report CT and MRI findings in two siblings presenting with HUS and secondary encephalopathy, with strikingly different radiographic features and outcome.

Case reports

Case 1

A 5-year-old boy presented with HUS requiring daily peritoneal dialysis. Two weeks after the onset impairment of consciousness occurred (Glasgow coma score 12) and hypoventilation (pCO₂ 57mm, pH 7.3), necessitating intensive care. The tone in his limbs progressively decreased, leading to a flaccid tetraparesis. MRI revealed increased signal from both putamina, more on the right, on fluid-attenuated inversion-recovery (FLAIR) images (Fig. 1a); on T1-weighted images these areas gave slightly low signal (Fig. 1b). There was no contrast enhancement. Over the following weeks the boy's renal function gradually improved and the neurological deficits resolved completely, while MRI performed 2 weeks after the first study revealed subtotal regression of the high-signal foci. The patient was discharged 30 days after his admission with no neurological sequelae.
**Figure 1a, b** Case 1. MRI on the day of onset of neurological deficits. **a** Axial FLAIR image through the basal ganglia demonstrating high signal from the putamina, especially the right. **b** These give slightly low signal on a T1-weighted sagittal image.

Case 2

The 1-year-old sister of the boy described above also presented with HUS and was admitted to the paediatric intensive care unit (ICU) 3 weeks after the onset. During initial peritoneal dialysis she became comatose and haemodynamically unstable, requiring intubation and ventilation. Intermittent generalised epileptic seizures were treated symptomatically. CT performed on the day of admission to the ICU revealed bilateral low attenuation areas in the basal ganglia and the frontal periventricular region. These were more pronounced 1 week later, while the child’s clinical status was unchanged. After another 2 weeks, however, dense areas had appeared around both temporal and frontal lobes in a cortical gyral configuration and at the periphery of the basal ganglia (Fig. 2a); they were surrounded by a rim of contrast enhancement.

MRI 1 week after admission to the ICU confirmed bilateral putaminal and caudate nucleus involvement, in the form of high signal on T1-weighted images (Fig. 2b), with peripheral contrast enhancement. FLAIR images also demonstrated high signal in the putamina and caudate nuclei and in the anterior limb of the internal capsule, presumably reflecting acute oedema (Fig. 2c). There was also extensive cortical involvement, predominantly in both temporal lobes and the right frontal and parietal lobes, with brain swelling seen as increased signal on FLAIR images and slight accentuation of the gyri on T1-weighted images (Fig. 2b), without enhancement. By 2 weeks later the cortical lesions had developed into gyriform high signal on T1-weighted images in the right frontal, parietal, temporal and left temporal cortex. The high-signal foci in the caudate nuclei and putamina on T1-weighted images had become more intense (Fig. 2d). Small components of slightly low signal were now seen in the cortical and periventricular regions on T2-weighted images. There was moderate laminar contrast enhancement along the cerebral gyri and around the basal ganglion lesions. The brain swelling had resolved, and generalised cerebral atrophy had developed (Fig. 2e).

The child still remained very unstable haemodynamically, constantly receiving a dopamine/noradrenaline infusion. Daily peritoneal dialysis had been complicated by acute peritonitis due to *Candida albicans* resistant to diflucan and *Staphylococcus epidermidis* resistant to methicillin. Generalised epileptic seizures continued intermittently, and there was limb myoclonus. There was no reflex response to painful stimulation.

With general agreement further investigation and close monitoring were interrupted. The girl was extubated and treatment was limited to supportive care. She died the following day.

Biopsies of the cerebrum through the anterior fontanelle were authorised. Multiple fragments of brain tissue were obtained from the right hemisphere, mainly the frontal region. Pieces of cortex, white matter, corpus callosum and periventricular region were identified. The tissue was variable in appearance from normal to yellowish, friable material. No abnormality was identified in the arachnoid. In the cortex there were many areas showing recent, organising laminar infarcts with necrotic debris, macrophages, small vessels with endothelial hyperplasia and slight reactive astrogliosis at their borders (Fig. 3a). Fragments from the caudate nucleus, with an ependymal lining, were identified and showed large areas of coagulative necrosis with many vessels partly or completely obliterated by fibrinoid necrosis, platelets aggregations or organising thrombi (Fig. 3b–d). A search for bacterial or viral infectious agents was negative.

**Discussion**

The neurological manifestations of HUS are variable, consisting mainly of seizures, partial or generalised and disturbances of consciousness, with stupor or coma. There may be motor or sensory deficits, impaired vision or brain-stem symptoms and signs [1, 2, 3, 4, 6]. Nonspecific neurological disturbances can result from arterial hypertension or metabolic imbalance secondary to acute renal failure. Definitive cerebral changes visible on CT or MRI, however, require a pathological substrate.