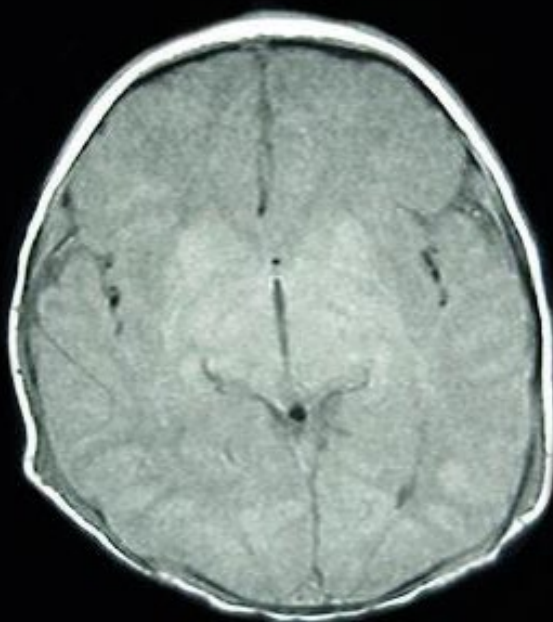


Early MRI and prognosis in
infants with hypoxic- ischemic
encephalopathy

April 2001



Assessing the prognosis of neonates with severe hypoxic-ischemic encephalopathy (HIE) in the first days of life requires a broad range of information including the history, clinical examination, laboratory investigations and EEG.

Early MR imaging has been reported to yield findings that correlate well with outcome and adds valuable prognostic information. Among other signs, loss of the normal signal from within the posterior limb of the internal capsule (PLIC) has been reported to accurately predict poor outcome in infants with HIE. Our recent experience with two infants with severe HIE demonstrates that interpretation of early MR sequences in asphyxiated newborns does require that neonatologists

Case 1

This male term infant (GA 41 6/7 weeks, BW 3540 g) was delivered by emergency Caesarean section because of a pathological CTG on admission with contractions. There was thick meconium-stained amniotic fluid. Umbilical cord pH values were 6.76/ and 7.02, and Apgar scores 4, 4, and 4 at 1, 5 and 10 minutes, respectively. He was intubated and ventilated within the first minutes of life. Blood gas analysis on admission to NICU at the age of 90 mins was as follows: pH 7.29, pCO₂ 4 kPa, BE -11 mmol/l, and the serum lactate was 10.9 mmol/l. Ventilator parameters could be reduced over the next 24-48 hrs, the cardiovascular system was stable requiring no inotropic support, and urinary output was normal. Apart from the encephalopathy there appeared to be little or no evidence for other organ failure.

Neurologically, he had hypoxic-ischemic encephalopathy (Sarnat grade II_III) with convulsions at 48 hours requiring phenobarbital. EEG showed a low amplitude (< 5mV) monomorphous beta-activity fronto-temporally and absent activity posteriorly.

In view of the probably poor prognosis, the appropriateness of continuing therapy was evaluated. The apparent lack of involvement of any other organs was considered unusual so MR imaging was performed on the DOL 4 (Fig. 1). This scan was interpreted as not showing any signs correlating with severe HIE. In view

of the unclear situation further metabolic and other investigations were performed which excluded, as far as possible, other causes of encephalopathy.

A second MR was performed on DOL 6 (Fig. 2) which now was reported to show mild to moderate changes consistent with severe HIE. The infant was now breathing spontaneously and sufficiently and could be extubated the next day. Unfortunately, he survived with severe neurological deficits.

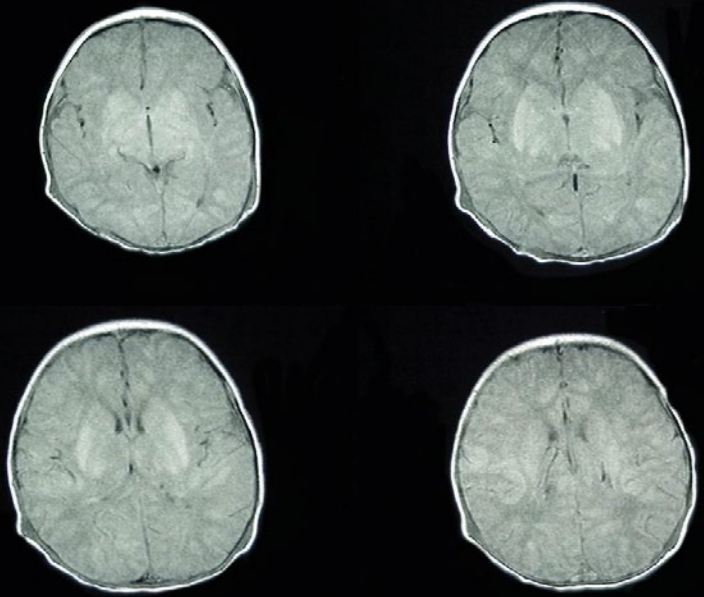
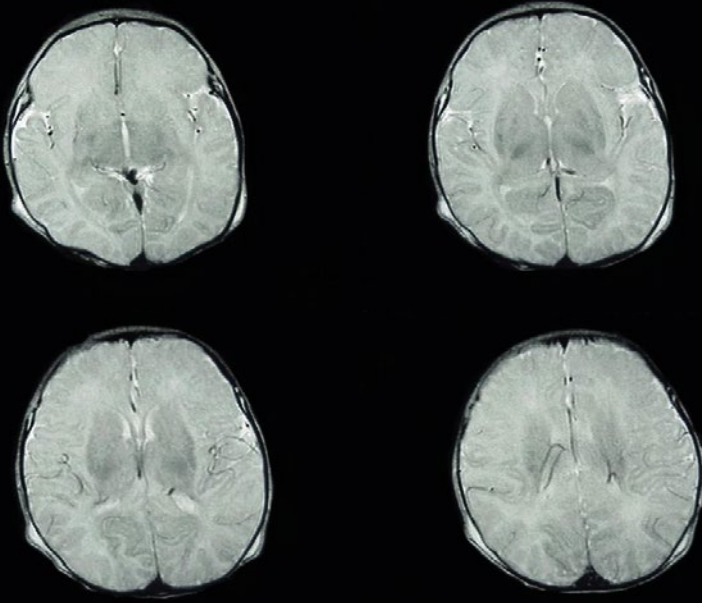


Fig. 1 a-d

MRI on day of life 4 (T1 sequence).



MRI on day of life 4 (T2 sequence).

Fig. 1 e-h

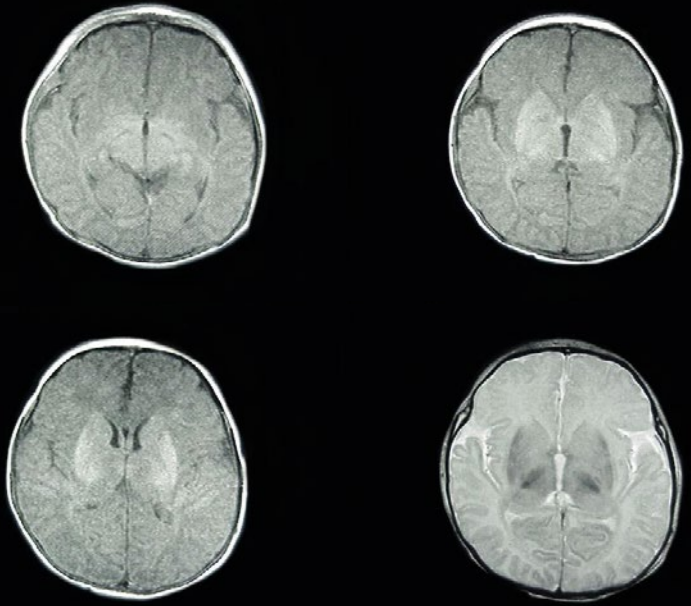
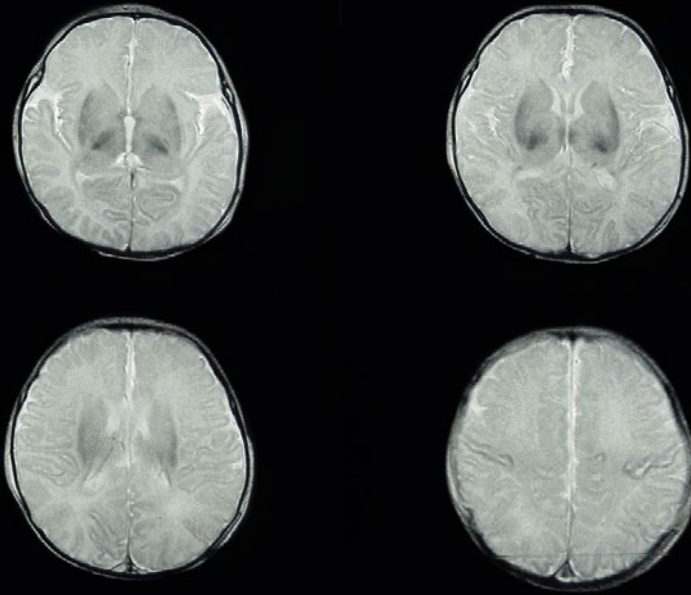


Fig. 2 a-d

MRI on day of life 6 (T1 sequence).

**Fig. 2 e–h**

MRI on day of life 6 (T2 sequence).

In view of the discrepancy between the MR reports and the clinical course in the first week of life on one hand and the reports on early MR findings in the literature on the other, we asked Mary Rutherford, MD, from the Hammersmith Hospital, London to evaluate the MR scans taken on day 4, day 6 and at 9 weeks (Fig. 3).

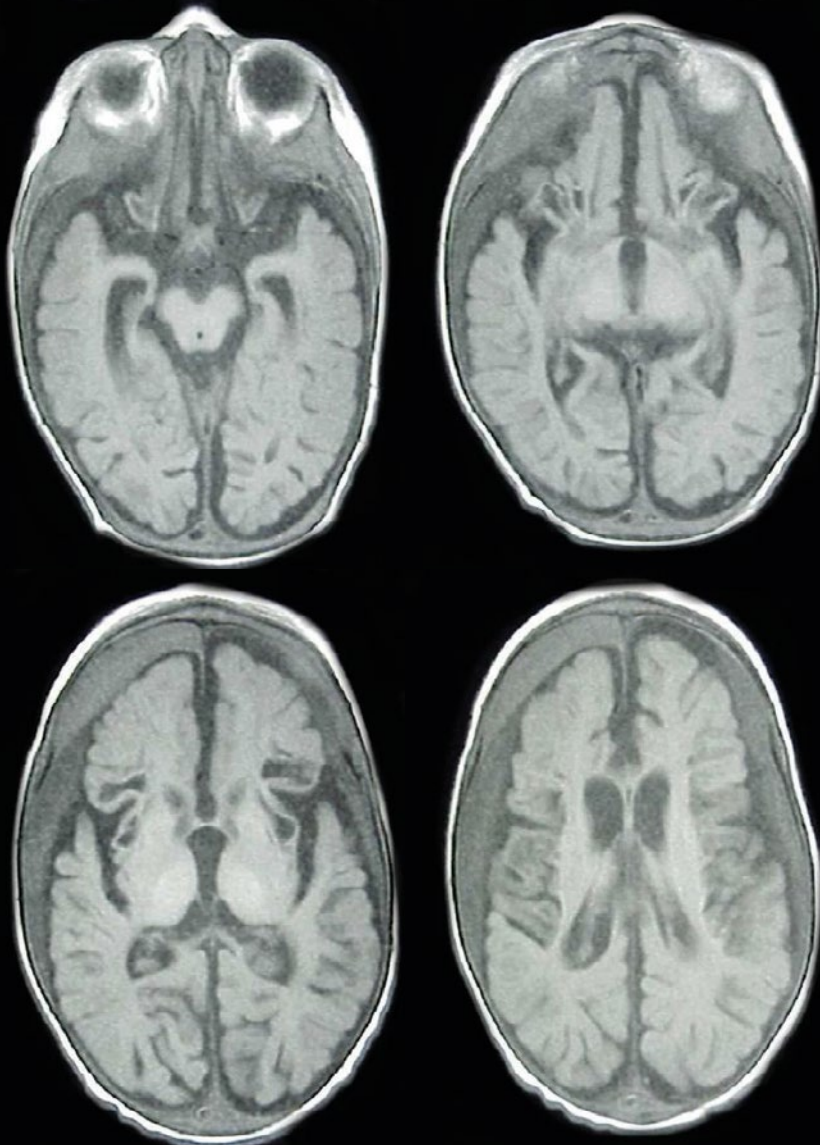
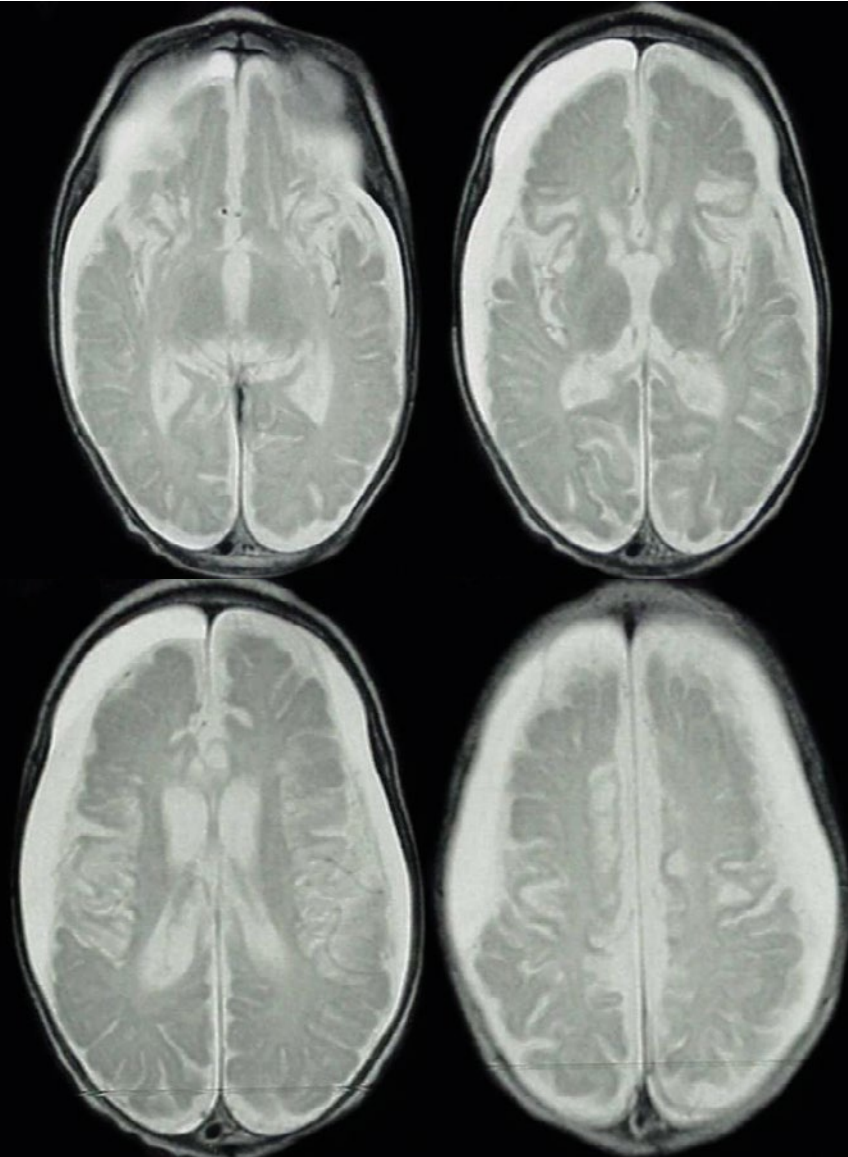


Fig. 3 a–d

MRI on day of life 9 (T1 sequence).



MRI on day of life 9 (T2 sequence).

Fig. 3 e-h

MR Report (M. Rutherford): Case 1

«The initial loss of grey/white matter differentiation heralded the infarction of the white matter which had occurred. The original basal ganglia were very abnormal with diffuse areas of abnormal high signal intensity on T1 with no myelin signal in the posterior limb. This is consistent with the 9 weeks scan where most of the lentiform nucleus has atrophied away and possibly the caudate (not all images were available). There is still no normal signal from myelin. The thalami are relatively preserved but look rather homogeneous. The baby clearly has developed widened extracerebral spaces and interhemispheric fissure plus some ventricular dilation. An effusion has filled the EC space. Babies who infarct their white matter as well as their basal ganglia and thalami after an acute documented perinatal asphyxia, may have primed their white matter in some way (perhaps with repeated hypoxic-ischemic events in utero or a more chronic insult). Infants with very severe events such as uterine rupture damage their basal ganglia and thalami but not usually develop widespread white matter infarction like this. Having said that, this is a pattern we have seen many times so it is not particularly unusual.»

Case 2

This male term infant (39 5/7 weeks, BW 4930 g) was born after an uneventful pregnancy but complicated delivery because of shoulder dystocia. At birth, the baby was cyanotic, limp, not breathing and without pulses. Cord pH values were 7.14/ and 7.24. In spite of resuscitation no pulse was detected for 20 minutes but a good pulse could be palpated at the age of 25 mins. Blood gas analyses from a umbilical venous catheter was 6.67 rising to 7.04 at 40 mins. and 7.14 at 60 mins. of age. On admission to our unit at the age of 90 mins, the pH was 7.28 with a BE -10 mmol/l and a serum lactate of 8 mmol/l. Mechanical ventilation was continued without difficulties, moderate inotropic support was tapered off over 24 hours. The child had clinical signs of encephalopathy progressing to Sarnat stage III on day 2-3. The EEG showed long stretches of very low amplitude activity with some burst-like activity at the age of 30 hours. An increase in EEG activity at 48 hours was accompanied by frequent generalized convulsions which were controlled with phenobarbital. MR imaging was performed at 60 hours of age and was reported as being mildly abnormal

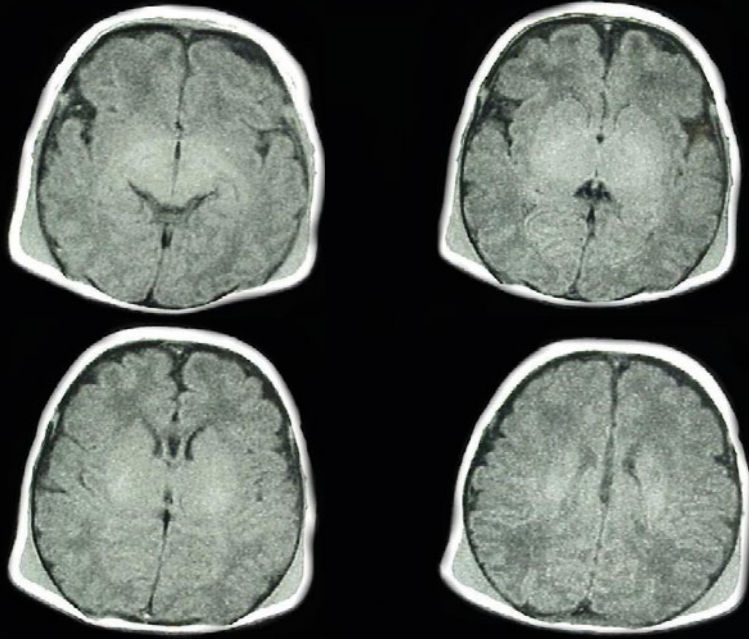


Fig. 4 a-d

MRI on day of life 3 (T1 sequence).

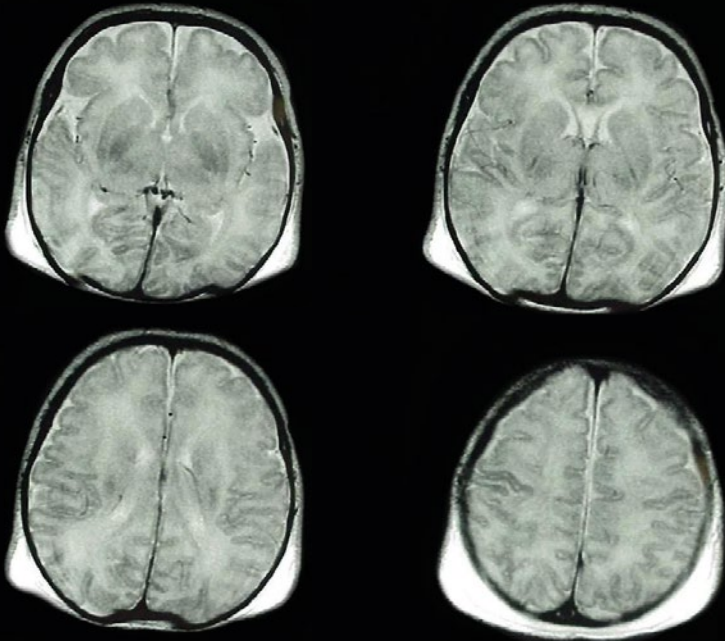


Fig. 4 e-h

MRI on day of life 3 (T2 sequence).

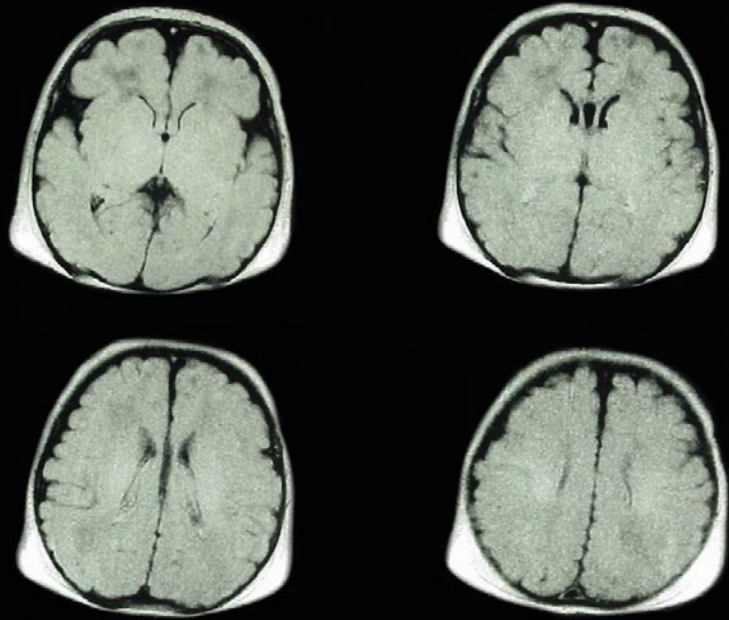


Fig. 4 i-l

MRI on day of life 3 (IR sequence).

In view of the history, the clinical findings of severe encephalopathy, the EEG and in agreement with the parents wishes it was decided that it was in the best interests of the child to discontinue intensive care. The child died shortly after withdrawing ventilator support on day 4. Permission for autopsy was refused on religious grounds.

We again asked Dr Rutherford for her interpretation of the scans.

MRI report (M. Rutherford): Case 2

«The T1 and T2 weighted images are all very abnormal. There is a swollen and amorphous appearance to the basal ganglia, thalami, midbrain and brainstem. There is no myelin in the internal capsule on the T1 weighted scans. The low signal intensity within the posterior limb of the internal capsule on the T2 weighted scans is slightly abnormal in its appearance being rather excessive and slightly straight. There are the beginnings of some abnormal low signal intensity regions within the basal ganglia and thalami on the T2 weighted scans. The white matter is excessively low signal intensity on the T1 and high signal intensity on the T2 weighted scans. These abnormal signal intensities extend out to the cortex. There is some loss of the normal grey / white matter differentiation. The sulci are narrowed in places. There is a suggestion of abnormal highlighting of the cortex. There are no suggestions that this baby

had pre-existing abnormalities of the brain which looks appropriately mature. These MRI findings are in keeping with the clinical history, and the clinical details. I would anticipate that the cortex is going to become more and more abnormal in appearance, mostly short T1 with associated infarction in the subcortical white matter. The abnormal signal intensity within the basal ganglia will also develop with more short T1 lesions appearing on the T1 weighted scans. The basal ganglia and thalami are then likely to atrophy as will the white matter. These MR findings would be associated with an abnormal neurodevelopmental outcome. The scans are still quite early but this outcome is likely to be severe with the development of a quadriplegia. This could also be associated with persistent feeding difficulties, the recurrence of convulsions after a few months and severe intellectual delay. These factors will depend on the eventual severity of his basal ganglia and thalamic lesions. This would be most obvious around 10-14 days.»

DISCUSSION

Evaluating the prognosis in infants with severe grade II or grade III HIE in the first days of life is often problematic. This can be particularly so in cases of severe encephalopathy where it is felt that continuing intensive care is inappropriate and not in the best interests of the child. In consultation with the parents, withdrawal of intensive care may be the appropriate ethical decision.

MR imaging may have a role in predicting abnormal outcome in the first days of life. Abnormal signal intensity in the posterior limb of the internal capsule has been reported to have a predictive probability distributed with a mean of 0.94 with 95% confidence limits of 0.89 to 1.0. Combining MR imaging with the clinical and EEG findings may allow for a higher degree of probability in ascertaining the prognosis. This information can be essential for evaluating the appropriateness of continuing life-sustaining therapy and for advising parents.

On the other hand, interpretation of MR scans in term infants with HIE requires expertise and awareness of the range of abnormal findings and their prognostic value. These findings need to be assessed against the background of normal developmental changes, which are seen on MRI in the term infant. Exchange of information and expertise between neonatologists and radiologists could help improve the information that can be gained from this investigation. Our two cases highlight our present limitations and perhaps demonstrate that there is a need for training opportunities for neonatologists in neonatal MR interpretation.

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