PROGNOSTIC VALUE OF PROTON MAGNETIC RESONANCE SPECTROSCOPY FINDINGS IN NEAR DROWNING PATIENTS

Reversibility of the early metabolite abnormalities relates with a good outcome

Maria de Fátima Vasco Aragão1,2,3, Meng Law1, João Prola Netto1, Marcelo Moraes Valença3, Thomas Naidich1

Abstract – In two children with near drowning hypoxic encephalopathy and normal-appearing structural MRI, acute proton magnetic resonance spectroscopy (1H MRS) showed biochemical alterations that correctly indicated prognosis and helped to guide management decisions. Elevation of the lipid-lactate and glutamine-glutamate peaks, on the early (72 hour) 1H MRS, predicts a poor prognosis. Absence of lipid-lactate and glutamine-glutamate peaks on the early 1H MRS and reversibility of early mild metabolite abnormalities on follow up examination relates with good outcome.

KEY WORDS: hypoxia, near drowning, magnetic resonance spectroscopy.

Valor prognóstico da espectroscopia de prótons em vítimas de quase-afogamento: reversibilidade das anormalidades metabólicas precoces relacionou-se com bom prognóstico

Resumo – Em duas crianças vítimas de quase-afogamento com encefalopatia hipóxico-isquêmica, que apresentaram ressonância magnética por imagem normal, a espectroscopia de prótons por ressonância magnética (1H MRS) na fase aguda mostrou alterações bioquímicas que corretamente indicaram o prognóstico e ajudaram a guiar o manejo terapêutico. Elevação dos picos de lipídeo-lactato e glutamina-glutamato na 1H MRS precoce realizada com 72 horas previu um mau prognóstico. Relacionaram-se com bom prognóstico; a ausência dos picos de lipídeo-lactato e glutamina-glutamato na 1H MRS precoce, e a reversibilidade no exame de controle (3 meses) das discretas anormalidades metabólicas encontradas no primeiro exame.

PALAVRAS-CHAVE: hipóxia, quase-afogamento, espectroscopia, ressonância magnética.

The term “near drowning” signifies patient survival for more than 24-hours after cardiorespiratory arrest due to submersion. Early prognostic of good outcome versus significant neurological deficit or death is important for correctly stratifying patient management1,2.

Magnetic resonance image (MRI) and computed tomographic findings of acute hypoxia ischemic injury are often subtle1-3. We describe the findings of early proton magnetic resonance spectroscopy (1H MRS) that helped to predict the prognosis.

METHODOLOGY

In two children with hypoxic-ischemic insult due to fresh water near drowning and normal-appearing structural MRI are studied.

RESULTS

Case 1

This 3-year-old girl suffered near drowning in a swimming pool. She experienced cardiorespiratory arrest, was...
MRI and MRS: drowning patients
Aragão et al.

resuscitated at poolside immediately after the accident, and arrived at hospital agitated but breathing spontaneously. MRI and ¹H MRS performed 72 hours after the near drowning (Fig 1A-D) showed normal anatomic structure (Fig 1A,D) and decrease (Fig 1C) of 20% in the N-acetylaspartate/creatinine (NAA/Cr=1.04) ratio, an increase of 26% in the choline/creatinine ratio (Cho/Cr=0.76) and 22% in the myoinositol/creatinine (Myo/Cr=0.74) ratios, but no lipid-lactate (Lip-Lac) peak. This patient had a good outcome and was discharged after 5 days with a normal neurological examination. Follow-up MRI and ¹H MRS 3 months after the near drowning (Fig 1E-F) showed normal anatomic structure (Fig 1F) and normal metabolites ratios (Fig 1E). (NAA/Cr=1.21, Cho/Cr=0.56 and Myo/Cr=0.62).

Case 2
This 6-year-old boy also suffered near drowning in a swimming pool. He arrived at the hospital in cardiopulmonary arrest, but was resuscitated and stabilized. MRI and ¹H MRS performed 72 hours after the near drowning (Fig 2A-C) showed apparently normal anatomic structure (Fig 2A-B) but significant metabolic abnormalities (Fig 2C), especially increased Lip-Lac and glutamine-glutamate (Glx) peaks. There was also decrease of 8% of the NAA/Cr (1.2) ratio and increase of 50% of Cho/Cr (0.9) ratio and 9% of Myo/Cr (0.65) ratio. The metabolic findings were interpreted as evidence of severe hypoxic injury with a poor prognosis. The patient remained comatose for 3 weeks, and progressed to non-progressive spastic/dystonic state, indicating chronic encephalopathy. The follow-up MRI and ¹H MRS was done 3 months after the accident (Fig 2D and E) and demonstrated severe brain atrophy (Fig 2D) and progression of metabolic changes (Fig 2E), with decrease of 54% in the NAA/Cr (0.6) ratio, an increase of 75% in the Myo/Cr (1.05) ratio, persistent of the Lip-Lac. However there was decrease in the Cho/Cr (0.6) ratio and Glx.

DISCUSSION
MRI and ¹H MRS may demonstrate abnormalities the first day after a hypoxic-ischemic near drowning injury, but have greater prognostic value after the third day. Edema and T2-hyperintensity in the cerebral cortex or basal ganglia are highly sensitive (100%) and specific (86%) predictors of poor prognosis (vegetative state and death). The two children presented here did not exhibit these features.

The transitory decrease in NAA/Cr ratio seen in our Case 1 with good outcome appears to correspond to reversible dysfunction of the neurons and glia after acute brain injury, not cell death, since the metabolites and the patient both recovered with no alteration in brain anatomy MRI on follow-up study. Transitory reduced NAA/Cr ratio has not been reported yet in a patient with good outcome after hypoxic-ischemic insult from near drowning, although had been described in other pathologic conditions and represents cellular dysfunction rather than cell death.

In Case 2 with poor outcome, the Glx levels were elevated on the 72-hour ¹H MRS, then decreased on follow up examination. This most likely reflects early initiation of the excitotoxic cascade in a patient with severe brain injury. The Myo/Cr was increased at 72 hours in both patients. The Myo/Cr returned to normal in Case 1 with
good outcome, but continued to increase in Case 2 with poor outcome. Myoinositol is found primarily in astrocytes and has a role in brain osmoregulation. The early but transient increase in Myo/Cr in Case 1 most likely reflects its role in osmoregulation. The progressive increase in Myo/Cr in Case 2 most likely reflects astrogliosis within the damaged brain.

Lactate is associated with anaerobic glycolysis, so the presence of Lip-Lac can reflect brain ischemia. Case 1 with no elevation of Lip-Lac on 1H MRS had a favorable outcome. Case 2 with elevated Lip-Lac levels had a poor outcome. These findings accord well with literature reports that elevated Lip-Lac peaks are strongly associated with poor outcome in brain injury, especially hypoxic-ischemic brain injury.

According to Dubowitz et al., the combination of MRI and 1H MRS together is superior to either one alone, decreasing the false-negative potential. 1H MRS complements conventional MRI and clinical findings. 1H MRS helps to predict the prognosis of near drowning victims with hypoxic encephalopathy and aids in triage, being particularly important in the hyperacute and acute phases, when conventional imaging findings are not prognostic.

In patients with near drowning hypoxic encephalopathy, 1H MRS can demonstrate biochemical alterations that aid prognosis and guide management decisions. Elevation of the Lip-Lac and Glx peaks, on the early (72 hour) 1H MRS, predicts a poor prognosis. Absence of lipid-lactate and glutamine-glutamate peaks on the early 1H MRS and reversibility of the early metabolite abnormalities on follow up examination correlates with a good outcome.

ACKNOWLEDGEMENT – We would like to acknowledge the assistance of Leonardo da Fonte, Claudia Fontana, Jose Ronaldo de Meinezes, and Adelia Henriques in the preparation of this manuscript.

REFERENCES