Diagnosing dural metastases: the value of $^1$H magnetic resonance spectroscopy

Abstract The purpose of this study was to assess the value of MRI, MR spectroscopy (MRS) and intra-arterial angiography in the preoperative diagnosis of extra-axial dural-based masses. We prospectively studied 54 patients who underwent preoperative MRI, MRS and angiography. Histologically there were 50 meningiomas and four dural metastases. MRI and angiography did not allow reliable differentiation between meningiomas and metastases. MRS showed elevated choline/creatine ratios in both meningiomas and metastases, but there were prominent lipid signals in all metastases and a lactate peak in two. This spectroscopic pattern was not found in meningiomas. However, following embolisation, they showed similar spectra, due to ischaemia and necrosis. We therefore believe MRS to be valuable in differential diagnosis of dural metastases and meningiomas prior to embolisation.

Key words Magnetic resonance spectroscopy · Magnetic resonance imaging · Angiography · Dural metastases · Meningioma

Introduction Dural metastases are found in approximately 9% of patients with terminal systemic cancer and in about 5% they represent the sole intracranial manifestation [1]. However, their frequency is dependent on the primary tumour: patients with prostate cancer and neuroblastoma are most commonly affected [1]. The appearance of dural metastases may be very variable, with diffuse dural thickening [2] or solid dural tumour nodules. In the latter case, differentiation from meningiomas may be very difficult [3, 4, 5, 6, 7]. Our purpose was to evaluate angiography, MRI and MR spectroscopy (MRS) in the preoperative diagnosis of extra-axial space-occupying lesion with a dural attachment.

Patients and methods We prospectively studied 54 patients with an extra-axial dural-based space-occupying lesion, thought to be a meningioma. They underwent MRI and MRS prior to angiography. MRI included T2- and T1-weighted images before and after intravenous contrast medium. MRS was performed at 1.5 tesla, with a protocol of single-voxel PRESS sequences (TE 135 and 270 ms, TR 1500 ms, 128 acquisitions) in at least one part of the lesion; voxel size ranged between 15 and 25 mm$^3$. Spectral postprocessing included 4 k zero-filling, gaussian apodisation, Fourier transformation, water-reference processing, frequency-shift correction and well as phase- and baseline-correction. Peak integral values were determined by a curve-fitting algorithm at 3.0 ppm for creatine (Cr), 3.2 ppm for choline-containing compounds (Cho), 1.35 ppm for lactate (lac) and 2.0 ppm for N-acetylaspartate (NAA). Peak integral values were normalised to the internal Cr peak.
**Fig. 1a-c** Case 1: a 70-year-old woman presenting with memory loss; neurological examination was normal. **a** T1-weighted DW image showing a left frontal extra-axial lesion with slight perifocal oedema. **b** Angiography revealed partial supply from the external carotid artery, which was embolised. **c** MRS showed no N-acetylaspartate (NAA) peak, elevated choline and creatine (Cho/Cr), lactate (lac) at 1.35 ppm and lipid signals at 0.8–1.3 ppm. A metastasis of a renal cell carcinoma was found. CT of the abdomen and scintigraphy revealed a left renal carcinoma and multiple bone metastases. The patient died 6 months later of a salmonella infection.

**Fig. 2a-c** Case 2: a 55-year-old woman complained of headache and absent-mindedness for about 6 months. She was operated upon for carcinoma of the breast (T1, N0, M0) 2 years previously, without evidence of local recurrence or metastatic disease. Neurological examination showed a mild left hemiparesis. **a** A contrast-enhanced T1-weighted image shows a parafalcine enhancing lesion and a dural tail. **b** Injection of the internal carotid artery showed pial supply. **c** MRS showed an elevated Cho/Cr, lipid signals and lac. Metastatic carcinoma of the breast was found.

All patients underwent transfemoral angiography with the aim of subsequent embolisation of the tumour. The feeding vessels and the extent of vascularisation were recorded. If feasible, external carotid artery feeding vessels were catheterised superselectively and embolised using trisacryl gelatin microspheres of 100–300 μm. Devascularised feeding vessels and the overall extent of devascularisation were recorded. MRI and MRS, using the same protocols and voxel positions as before embolisation were performed 2 h after embolisation, with up to 5 follow-up examinations. The diagnostic accuracy of MRI and angiography was assessed prior to surgery by two neuroradiologists.