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ORIGINAL ARTICLE

Central neurocytoma: Radiological and clinico-pathological findings in 18 patients and one additional MRS case

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KEYWORDS
Central neurocytoma (CN);
Apparent diffusion coefficient (ADC);
Normalised apparent diffusion coefficient (NADC);
Axial fluid attenuated inversion recovery (FLAIR);
Magnetic resonance spectroscopy (MRS)

Summary
Objectives: To evaluate clinical findings and radiological characteristics of central neurocytoma (CN) in 18 patients and magnetic resonance spectroscopy (MRS) features in one additional case.
Materials and methods: Clinical and imaging findings of 18 patients (nine female and nine male; age range, 18—37 years old (27.8 ± 5.7)) with histopathological diagnosis of CN were evaluated retrospectively. Eight patients underwent CT and eight had MR imaging. Both MR and CT images were acquired for other two patients. We also assessed the tumour NADC values. Clinical data, such as presenting symptoms and medical histories were collected. MRS was also obtained for one additional case.
Results: Clinical symptoms at the time of presentation were headaches ($n = 11$), dizziness ($n = 6$), visual disturbances ($n = 2$), etc. Eight lesions were unilateral ventricle (44%) and ten were located in both lateral ventricles. Three tumours continued towards the foramen of Monro and one to the third ventricle. The maximum diameter of the CNs varied from 3.4 to 9.2 cm (5.2 ± 1.5 cm). On CT, diffuse and diverse calcifications were observed in nine cases and cysts varying in sizes were revealed in all. On MRI, the solid parts of the tumours were mainly hypo- to isointense on all T1WI and isointense to grey matter on T2WI. Clusters of cysts gave the tumours a ''swiss cheese/soap bubble'' inhomogeneous hyperintense appearance on T2WI and FLAIR images. Heterogeneous moderate enhancement (5/8) was present on T1 postcontrast images. On DWI, the tumours had heterogeneous hyperintense appearances and the tumour NADC values were 0.93 ± 0.21.On MRS, elevated Cho and Gly peaks and reduced Cr and NAA peaks were obtained.

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Conclusion: CN is almost exclusively located in the body of lateral ventricle in young adults. It is discovered due to symptoms of raised intracranial pressure. The distinct radiological features such as: (1) diffuse and diverse calcifications on CT images; (2) clusters of cysts of varying sizes resulting in the ''swiss cheese/soap bubble'' appearance on T2WI and heterogeneous moderate enhancement on MR images; (3) the incorporation of the septum pellucidum in bilateral tumours and abutting of the septum pellucidum in unilateral tumours together with the attachment of the wall of the ventricles can help in the diagnosis of preoperative central neurocytoma.

Introduction

Central neurocytoma (CN) was originally described by Hassoun et al. in 1982, and became a well-defined clinical and pathological entity [1,2] by the early 1990s. The first report resulted in increased recognition of the tumor, and a number of reports have since been published in the literature. Nevertheless, CN remains a rare neoplasm of the central nervous system, representing 0.25—0.5% of primary intracranial tumors and nearly 10% of intraventricular tumors [3—5]. CN typically arises in young adults in their third decade of life. Almost 69% of described cases occurred in patients between 20 and 40 years of age, with an average age of 30 years [5,6]. However, it can, on rare occasions, arise in the first decade of life and after 50 years of age [7].

CN is a tumor of neuronal origin [8—10] that is preferentially located in the ventricular system, mainly in the frontal horn of the lateral ventricles and in the region of the foramen of Monro [11,12]. Histologically, CN corresponds to World Health Organization (WHO) grade II, and its International Classification of Diseases for Oncology (ICD-O) behavior grade is 1 (low or uncertain malignant potential, or borderline malignancy). Its diagnosis and management remain controversial, as it may be confused radiologically with oligodendroglioma, ependymoma, subependymal giant cell astrocytoma and choroid plexus papilloma. WHO grade II astrocytoma and oligodendroglioma have an ICD-O behaviour grade of 3 (malignant) and, thus, reinforce the fact that CN has a better prognosis compared with other intra-axial brain tumors presenting in the same age group.

The present study represents the largest imaging series of CN so far, and was conducted to evaluate the clinical findings and to define the characteristic imaging features of the tumor to enable more accurate diagnosis of suspicious lesions before surgery.

Materials and methods

The present retrospective study was conducted using the pathology archives at our hospital with the approval of the review board and ethics committee of our institution. From January 2007 to July 2010, a series of 44 histopathologically confirmed CN cases was collected. The histological diagnosis was based on the tumor sample harvested intraoperatively and confirmed by immunohistochemistry.

Of these 44 patients, only 18 underwent preoperative conventional radiological procedures at our hospital. The evaluated patients consisted of nine women and nine men, with an age range of 18 to 37 years (average: 27.8 ± 5.7 years) at the time of observation. Eight patients had undergone computed tomography (CT) with and without intravenous injection of iodinated contrast, and eight had undergone magnetic resonance imaging (MRI). Both MRI and CT scans were acquired for two other patients. Of the 44 cases, one patient, a 24-year-old woman, also underwent magnetic resonance spectroscopy (MRS) at our hospital.

MRI was performed on either a 1.5-T scanner (Signa EXCITE HD 1.5T^{TM} TwinSpeed; GE Healthcare Bio-Sciences, Little Chalfont, Buckinghamshire, UK), a 3.0-T device (Signa VH/i 3 T/94) or a 3.0-T MAGNETOM Verio (Siemens AG, Erlangen, Germany). Axial and sagittal non-enhanced, T1-weighted, spin-echo [SE] images were obtained in the 10 patients who underwent MRI. Additional unenhanced images were available in eight patients, and included axial T2-weighted and axial fluid-attenuated inversion recovery [FLAIR] sequences. Subsequently, axial Gd-DTPA-enhanced (gadolinium-diethylenetriamine pentaacetic acid) T1-weighted SE images were also acquired in these eight patients. Furthermore, diffusion-weighted imaging (DWI) was performed using axial, multislice, single-shot, echo-planar SE sequences in seven patients. Apparent diffusion coefficient (ADC) maps were calculated on a pixel-by-pixel basis. For an exact demonstration of tumor heterogeneity, at least five uniform regions of interest 10—20 mm^2 in size were selected from different areas of non-cystic/non-calcified parts of tumor with contrast enhancement and from normal-looking parietal white matter. Minimum ADC values were taken into consideration. In addition, all measured tumor ADC values were divided by normal ADC values to obtain normalized ADC (NADC) values.

For MRS, spectral and metabolite maps for each 'slice' along the third dimension were extracted using the FuncTool Display. Within the obtained volume of interest (VOI), separate voxels were individually placed in different parts of the tumor. The metabolite peaks used were: N-acetylaspartate (NAA) at 2.02 ppm; choline-containing compounds (Cho) at 3.22 ppm; (phospho-) creatine (Cr) at 3.01 ppm; and glycine (Gly) at 3.55 ppm. Metabolite ratios (maximum Cho/Cr and Cho/NAA ratios) were calculated from the metabolite maps using the relevant software.

CT was performed in 10 patients, using a SOMATOM Emotion 6 CT scanner (Siemens). Routine head CT scans were done, resulting in 12 slices, each of which was 5-mm thick.

Two experienced radiologists (H.R. and H.H.) reviewed all of the imaging data retrospectively for location, size, margins, density, signal intensity and enhancement characteristics, and meticulously examined the images for the presence of calcifications, cysts and necrotic changes in the lesions. The presence or absence of hemorrhage, vascular signal voids, ventricular dilatation and adjacent