Clinical Neurology and Neurosurgery 138 (2015) 78–82

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Preoperative radiologic characters to predict hemangiopericytoma from angiomatous meningioma

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ARTICLE INFO

Article history:
Received 8 June 2015
Received in revised form 26 June 2015
Accepted 6 August 2015
Available online 13 August 2015

Keywords:
Hemangiopericytoma
Angiomatous meningioma
MRI
DWI
ADC

ABSTRACT

Background: Hemangiopericytoma is clinically difficult to be differentiated from angiomatous meningioma. We set out to determine if the preoperative MRI parameters can predict HPC from angiomatous meningioma.

Methods: A retrospective review of medical records was conducted for12 HPC patients and 17 angiomatous meningiomas. WHO-2007 grading was used for histopathological diagnosis. Preoperative radiologic parameters included tumor location, tumor size, tumor shape, T1-weighted signal, T2-weighted signal, T1-weighted Gd-enhanced image, ADC value, Flair signal, peritumoral edema (PTE), dural tail sign (DTS), vessel voids sign, arachnoid layer on T2-weighted MRI, tumor hemorrhage and necrosis were analyzed. Univariate analyses were conducted to examine the association between radiological or clinical and histopathological features. Binary logistic regression model was used to evaluate if the parameters predict the occurrence of HPC.

Results: Five parameters, included age, gender, ADC value, necrosis and T1 enhancement was found significantly different between two types after univariate analyses. Binary logistic regression model demonstrated ADC value was the sole independent predictor of HPC ($p = 0.039$, OR: 14.5, CI—3.7–38.6).

Conclusions: ADC value may be used as a simple and useful optional tool in differentiating primary intracranial HPC from angiomatous meningioma. The combination of ADC value with the data acquired from pre and post-contrast MR scans may further help improve the reliability in the differential diagnosis.

1. Introduction

Hemangiopericytoma (HPC) is a rare tumor of vascular origin that was first described by Stout and Murray [1]. In the central nervous system (CNS), HPC closely resembles angiomatous meningioma radiologically despite being a distinct histopathological entity. HPC deserves special attention because the intraoperative blood loss during its resection is large, and it is known to recur and metastasize [2]. Angiomatous meningioma accounts for 2.1% of all meningiomas [3]. It has features of a typical benign meningioma with many small or large vascular channels which may predominate over its meningothelial elements. Thus, preoperative differentiation of HPC and meningioma may be advantageous, as this information could be of help in surgical and treatment planning. For this reason, we set out to determine if the preoperative MRI parameters can predict HPC from angiomatous meningioma.

2. Patients and methods

2.1. Patients

From January 2005 to December 2014, the imaging data of 29 patients (14 men and 15 women; mean age: 45.4 ± 8.9 years; age range: 26–61 years) in Nanfang Hospital were retrospectively reviewed. Preoperative MRI, operative notes and surgical specimen were re-evaluated. Previously treated tumors were excluded. The histopathology slides were re-evaluated and the histopathological diagnosis was classified based on the 2007 WHO classification system. This retrospective study was approved by Nanfang Hospital Medical Ethics Committee. Patient records/information was anonymized and de-identified prior to analysis. The clinical records of participants in this study were de-identified prior to analysis.

2.2. MR imaging

MRI examinations were performed using a 3-T machine for all patients (General Electric Signa Excite HD). The MRI protocol included the following sequences: T1-weighted images (TR/TE, 436/21 ms), T2-weighted images (TR/TE, 5000/125 ms; echo train

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http://dx.doi.org/10.1016/j.clineuro.2015.08.005
0303-8467/

length 8) and FLAIR images (TR/TE/TI, 9000/145/2100 ms). DW MR imaging was acquired in the axial plane by using *b*-values of 1000 s/mm^2 with section thickness of 5 mm. ADC values were measured automatically using the Func-Tool software program (GE Medical Systems). The ADC was determined by manually placing the regions of interest (ROIs) in the respective tumor sites on the ADC maps of $b = 1000$ by the coauthors who were blind to the tumor grade. All consecutive slices that included the solid portion of the tumors were initially selected. ROIs were purposely placed at the center of tumors to avoid volume-averaging with vessel voids, cystic, necrotic, and hemorrhagic regions that might influence the ADC values, and to avoid capsule-lesions. Based on 3–5 ROIs on the ADC maps, the ADC values of each tumor were calculated. Slice thickness was 5 mm, and the field of view varied between 18 and 30 cm. We also obtained axial, coronal, and sagittal T1-weighted images after administration of 0.1 mmol/kg of body weight of Gd-DTPA.

Preoperative MRI parameters analyzed in this study included: tumor location (skull base or convexity), tumor size (maximum diameter), tumor shape (tumor with irregular shape, including mushroom shape or lobulated, tumor with regular shape, including globular shape), T1-weighted signal (hyper, hypo or isointense compared with gray matter), T2-weighted signal (hyper, hypo or iso-intense compared with gray matter), T1-weighted Gd-enhanced image (heterogeneity or homogeneity), ADC value, Flair signal (hyper, hypo or iso-intense compared with gray matter), peritumoral edema (PTE), dural tail sign (DTS), vessel voids sign, arachnoid layer on T2-weighted MRI, tumor hemorrhage and necrosis. Necrotic components were differentiated on contrast enhanced T1-weighted images as the interior non-enhancing parts of enhanced lesions. Hemorrhagic lesions were differentiated on non-enhanced T1-weighted MR images as hyperintensity sites and T2-weighted MR images as focal hypointensity sites. The assessment of DTS was accomplished using the following Goldsher et al.'s criteria [4].

2.3. Statistical analysis

Mean, standard deviation, median and range for continuous variables; and frequency for discrete data were calculated for patient demographics. Univariate analyses (chi-square test for categorical variables and one-way ANOVA or Kruskal–Wallis test for continuous variables) were conducted to examine the association between radiological or clinical and histopathological features. Binary logistic regression model was used to evaluate if the parameters predict the occurrence of HPC. For all analysis, $p < 0.05$ were considered statistically significant. SPSS 20 (Chicago, Inc, IBM) was used for all the statistical analysis.

3. Results

3.1. Clinical results

12 cases of HPCs and 17 cases of angiomatous meningiomas were confirmed by two pathologists who were blinded to the diagnosis. The mean age of HPC patients was younger than that of meningioma patients (41.4 years vs 48.2 years, one-way ANOVA, $p = 0.041$), and the mean largest diameter of HPC was not different from that of meningioma (4.1 cm vs 4.7 cm one-way ANOVA, $p = 0.062$). The gender between angiomatous meningiomas and HPC patients was different (chi-square test, $p = 0.016$). The tumor location (chi-square test, $p = 0.46$) and tumor shape (chi-square test, $p = 0.064$) was not different between angiomatous meningiomas and HPC patients.

3.2. MR imaging findings

There were, respectively, 0, 6, 6 patients with HPC demonstrating hyper-intensity, iso-intensity and hypo-intensity on T1 image, while the number for patients with meningioma was 0, 5, 12 (Kruskal–Wallis test, $p = 0.269$). There were, respectively, 6, 6,

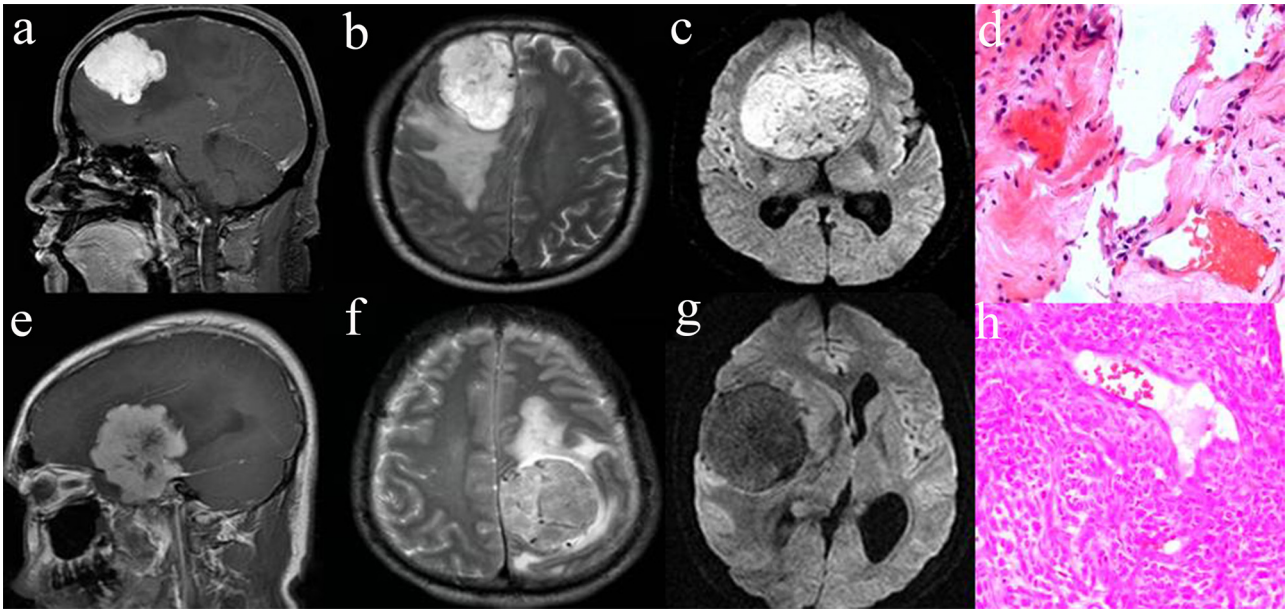

Fig. 1. (a–d) Representative MRI image of angiomatous meningioma; (e–h) representative MRI image of HPC (a) angiomatous meningioma showed homogeneous enhancement even tumor grew into a large size and irregular tumor shape can be seen; (b) PTE, arachnoid layer and vessel voids sign can be seen in T2 weight image of angiomatous meningioma; (c) angiomatous meningioma showed high signal in DWI image(low ADC value); (d) Hematoxylin and eosin (H&E) stained sections showed highly vascular tumor consisting predominantly of dilated vascular spaces with intervening areas showing spindle to oval cells with abundant cytoplasm and oval vesicular nuclei. (e) HPC showed heterogeneous enhancement and irregular tumor shape can be also seen; (f) PTE, arachnoid layer and vessel voids sign can be seen in T2 weight image of HPC; (g) HPC showed low signal in DWI image(high ADC value); (h) Paraffin section of hemangiopericytoma showing tightly packed monomorphic cells with prominent vascularity and rich reticulin network.