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Assessment of solid lesions of the temporal fossa with diffusion-weighted magnetic resonance imaging

A. A. K. Abdel Razek
Department of Diagnostic Radiology, Mansoura Faculty of Medicine, Mansoura University, Mansoura, Egypt

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Abstract. The aim of this work was to assess solid lesions of the temporal fossa with diffusion-weighted magnetic resonance imaging (MRI). A retrospective analysis of diffusion-weighted MRI obtained for 33 patients with solid lesions of the temporal fossa was conducted. Fifteen of the patients were male and 18 were female, and their mean age was 39 years. The apparent diffusion coefficient (ADC) of solid lesions of the temporal fossa was calculated on two separate occasions by the same observer. The mean ADC values ($\times 10^{-3}$ mm^2/s) of the two readings in cases of malignancy (0.98 ± 0.17 and 0.95 ± 0.13) were significantly different to those of benign lesions (1.32 ± 0.24 and 1.28 ± 0.21) ($P = 0.001$ and 0.001), with excellent intra-observer agreement ($\kappa = 0.937$). The area under the receiver operating characteristic curve was 0.855. A threshold ADC of 1.23×10^{-3} mm^2/s was found to have an accuracy of 91%, with sensitivity of 94% and specificity of 85%, for differentiating malignancy of the temporal fossa from benign lesions. It is concluded that ADC is a non-invasive imaging parameter that is able to differentiate malignancy of the temporal fossa from benign lesions.

Key words: diffusion; magnetic resonance imaging; tumour; masticator.

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The temporal fossa is the superior extent of the masticator space located superior to the zygomatic arch.[1] The temporal fossa is an important region in maxillofacial surgery, as it is located adjacent to various anatomical spaces and important structures, such as the scalp, eyelid, and face. Surgery for solid lesions of the temporal fossa varies depending on the type of lesion – benign or malignant.[2,3]

A spectrum of malignant tumours and benign solid lesions are reported in the temporal fossa. These tumours may arise from the soft tissue of the temporal fossa or extend from the adjacent spaces.[1–4] The early differentiation of malignant tumours of the temporal fossa from benign lesions is important for treatment planning.[4,5] A few studies have assessed the role of imaging in the evaluation of the temporal fossa.[1–4] Both routine computed tomography (CT) and magnetic resonance imaging (MRI) are accurate for the assessment of the location and extension of lesions in the temporal fossa.[1,6] Advanced MRI sequences such as dynamic susceptibility perfusion-contrast MRI and MR spectroscopy are used to differentiate malignant tumours from benign lesions of the head and neck, but results are overlapping.[7,8]

Biopsy is an invasive procedure and may be associated with complications.[9]

Diffusion-weighted MRI offers better characterization of tissues and their physiological processes, because it reflects the random motion of water protons that are disturbed by the presence of intracellular organelles and macromolecules. Thus, the apparent diffusion coefficient (ADC) values of tissues vary according to the pathology of the lesion.[10–13] Diffusion-weighted MRI has been used to differentiate malignant tumours from benign lesions in the body and head and neck.[10–15] Recently, diffusion-weighted MRI has also been used to differentiate malignancy from benign lesions and infection of the masticator space.[16,17]

The aim of this study was to assess solid lesions of the temporal fossa with diffusion-weighted MRI.

Materials and methods

A retrospective analysis of 34 patients with temporal fossa lesions was performed. Untreated patients with solid lesions of the temporal fossa who had undergone routine and diffusion-weighted MRI series were identified; images were obtained from the hospital database. The image quality for one of the patients was poor, due to motion artefacts, and this patient was excluded from the study. Thus a total of 33 patients were included. Fifteen were male and 18 were female, and their mean age was 39 years (range 5–66 years). These patients presented with facial swelling ($n = 28$), facial pain ($n = 19$), trismus ($n = 18$), and proptosis ($n = 5$).

MRI of the head and neck was performed with a 1.5 Tesla MRI machine (Symphony; Siemens AG Medical Systems, Forchheim, Germany) using a head circular polarization surface coil. All patients underwent transverse T1-weighted images (repetition time/echo time (TR/TE) of 800/15 ms) and T2-weighted fast spin echo images (TR/TE of 4500/80 ms), with a section thickness of 5 mm. Diffusion-weighted MRI was obtained using a multi-slice echo-planar imaging sequence. The imaging parameters were TR/TE of 1000/108 ms, field of view (FOV) of 25×20 cm, an acquisition matrix of 256×128, and section thickness of 5 mm. Diffusion-weighted MRI was acquired with diffusion-weighted factor b-values of 0, 500, and 1000 s/mm^2. The ADC map was calculated automatically by commercially available software (Leonardo, version 2.0; Siemens AG Medical Systems). The data acquisition time for the diffusion-weighted MRI was 1 min. Finally, contrast-enhanced fat-suppressed T1-weighted images (TR/TE of 800/15 ms) were obtained after intravenous bolus injection of 0.1 ml/kg body weight of gadopentetate dimeglumine.

Image analysis was performed by one radiologist (with 20 years of experience in head and neck imaging) who was blinded to the final histopathological results. A free-hand region of interest (ROI) was drawn around the margin of the solid lesion with an electronic cursor on the ADC map. The same observer performed a second reading on a separate occasion. The final diagnosis of the temporal fossa lesions was confirmed on histopathological examination of either a surgical excision sample ($n = 16$) or a biopsy sample ($n = 17$).

The statistical analysis of data was done using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). The analysis of data was done to test for a statistically significant difference between malignant tumours and benign lesions of the temporal fossa. The Student t-test was used for comparisons between two groups. For comparisons between more than two groups, one-way analysis of variance (ANOVA) was used. The kappa statistic (κ) was done to estimate the proportion of agreement for the two readings. The κ-values were interpreted as follows: 0.00–0.20 indicates poor agreement, 0.21–0.40 indicates fair agreement, 0.41–0.60 indicates moderate agreement, 0.61–0.80 indicates good agreement, and 0.81–1.00 indicates excellent agreement. A receiver operating characteristic curve of both readings was obtained, and the area under the curve calculated. The cut-off ADC value with the highest accuracy to differentiate malignancy from benign lesions of the temporal fossa was determined and the sensitivity and specificity calculated. A P-value of ≤ 0.05 at a confidence interval of 95% was considered significant.

Results

The final diagnosis of the solid lesions of the temporal fossa was a malignant tumour in 19 patients and a benign lesion in 14. The malignant tumours of the temporal fossa were non-Hodgkin lymphoma ($n = 4$) (Fig. 1), rhabdomyosarcoma ($n = 3$), squamous cell carcinoma ($n = 2$), fibrosarcoma ($n = 2$), malignant peripheral nerve sheath tumour ($n = 2$),

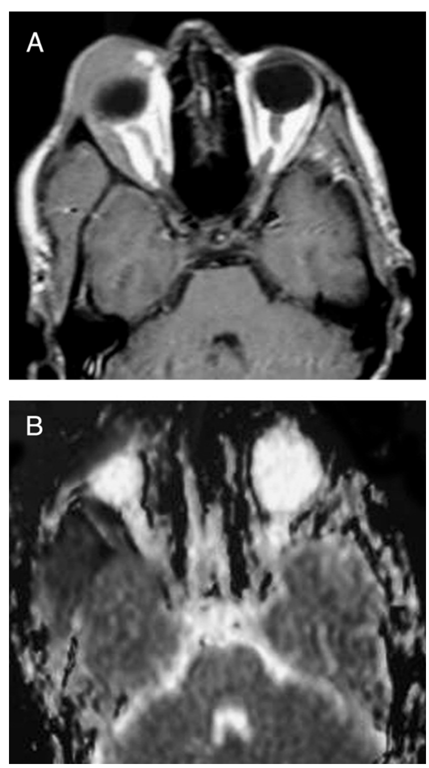

Fig. 1. Non-Hodgkin lymphoma of the temporal fossa. (A) Axial contrast T1-weighted image showing a large infiltrating and enhancing mass in the right temporal fossa, with extension into the right lateral rectus muscle and pre-septal space in front of the right globe, and right proptosis. (B) ADC map showing restricted diffusion, with a low ADC value (0.83×10^{-3} mm^2/s) of the lesion in the right temporal fossa, right lateral rectus muscle, and pre-septal space.