European Journal of Radiology 85 (2016) 324–336

Contents lists available at ScienceDirect

European Journal of Radiology

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

Characterization of orbital masses by multiparametric MRI

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ARTICLE INFO

Article history:
Received 4 August 2015
Received in revised form
25 November 2015
Accepted 30 November 2015

Keywords:
Orbital masses
Orbital MRI
Multiparametric MRI
Diffusion weighted imaging
Dynamic contrast enhanced imaging

ABSTRACT

Objectives: DWI and dynamic contrast enhanced (DCE) MR imaging are techniques that allow insight to tumor vascularity and cellularity. We evaluated the diagnostic performance of multiparametric MRI (mp-MRI) in distinguishing benign from malignant orbital masses using standard anatomic imaging (sAI), DWI and DCE.

Materials and methods: This prospective IRB approved study with written informed consent included 65 patients. mp-MRI at 3 Tesla including DWI and DCE was performed in all patients. Parametric maps were generated for obtaining the perfusion parameters including K^{trans}, k_{ep}, v_e and iAUC and time-signal intensity curves were recorded to determine the curve pattern. Two radiologists rated the likelihood of malignancy on a five-point scale in three separate, randomized reading sessions (initially only sAI, afterwards sAI + either DWI or DCE and finally sAI + DWI + DCE). Data was statistically analyzed.

Results: 33 Patients had malignant orbital masses and 32 patients had benign orbital masses (reference standard histopathology in 35 cases and clinical follow-up in 30 patients). The mean ADC of malignant masses differed significantly from the mean (SD) ADC of benign masses (0.825 [0.437] $\times 10^{-3}$ mm^2/s and 1.257 [0.576] $\times 10^{-3}$ mm^2/s, respectively) ($p = 0.001$). K^{trans}, k_{ep} and iAUC were significantly higher in malignant masses ($p < 0.01$). The reading of sAI only resulted in a moderate specificity but poor sensitivity in differentiating benign from malignant lesions. Adding DWI and DCE images improved specificity and sensitivity considerably, being the highest for the combined reading of all sequences.

Conclusion: mp-MRI is a helpful tool in differentiating malignant orbital lesions from benign masses and should therefore be included in the routine diagnostic protocol for orbital imaging.

1. Introduction

Orbital and intraocular masses are relatively uncommon compared to other mass lesions of the body. It has been described that two-thirds of orbital tumors are benign and one third is malignant [1]. Characterization of orbital masses is crucial in the therapeutic strategy planning [2] as the patient management differs greatly depending on the dignity of the orbital mass [3]. However, it is often difficult to differentiate malignant orbital masses from benign ones due to their similar clinical presentation with proptosis as the most common symptom [4]. Magnetic resonance imaging (MRI) may help finding the diagnosis as there are some pathognomonic features for particular masses as for instance the cavernous hemangioma [5]. But for cases without these pathognomonic characteristics it remains difficult to deliver a diagnosis based on MR imaging features because there are often unspecific and overlapping imaging findings [5]. Aggravating this situation, rare tumor entities are unexpected and therefore may be misdiagnosed [5]. It has even been proposed that none of the orbital imaging features including CT and MR imaging features had sufficient sensitivity to distinguish between malignant and benign orbital masses [6].

Published data indicate that the use of advanced MRI sequence techniques like diffusion weighted imaging (DWI) with quantitative apparent diffusion coefficient (ADC) mapping and dynamic contrast-enhanced (DCE) MR imaging may provide additional information about the dignity and entity of orbital masses [5,7–14]. Based on the diffusivity of water in tissue DWI exploits the fact that the movement of water is normally restricted in malignant tumors, whereas DCE offers information on the rate of uptake and clearance of contrast media and can be analyzed to derive information on tissue and tumor vascularity. Tofts defines a compartment

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http://dx.doi.org/10.1016/j.ejrad.2015.11.041
0720-048X/

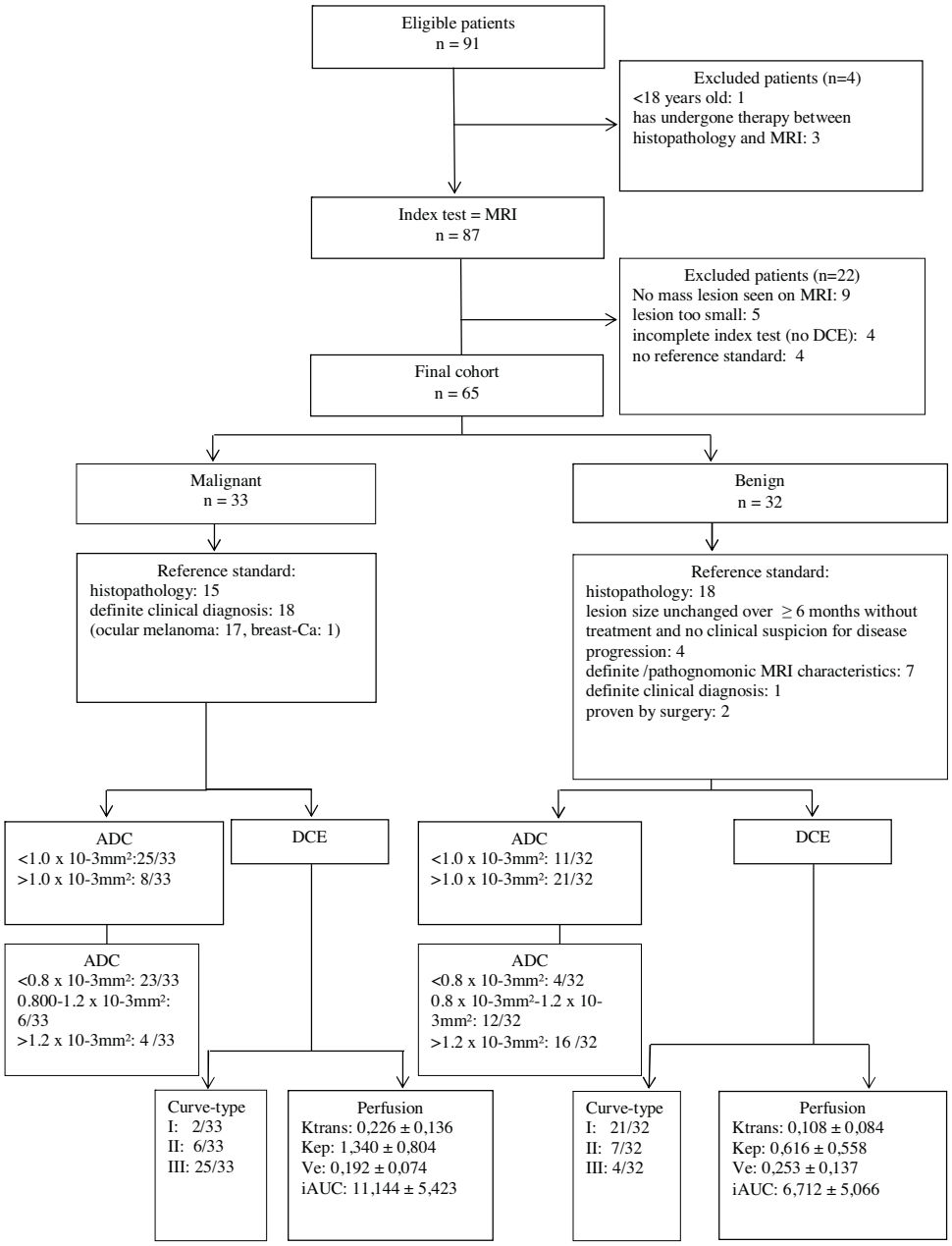

Fig. 1. Selection process of patients and detailed results of the quantitative analysis.

model to describe abnormal capillary leakage and uses the following parameters: K^{trans} = volume transfer constant between blood plasma and extravascular extracellular space (EES) in abnormal tissue, k_{ep} = efflux rate constant from EES to blood plasma, v_e = EES volume per unit volume of tissue and iAUC = initial area under the gadolinium concentration curve during the first 60 s [15]. Taking advantage of either of these, DWI and DCE, there are several research groups who have investigated multiparametric magnetic resonance imaging (mp-MRI) of the orbital cavity by adding one functional parameter such as DWI or DCE to the standard morphological sequences [4,5,7,17,18]. There were suggestions that DCE or DWI may produce complementary information [19]. However, to our knowledge, the diagnostic performance of combining conventional magnetic resonance imaging with DWI and DCE has not been investigated.

The purpose of our study was to prospectively evaluate the diagnostic performance of mp-MRI in distinguishing benign from malignant orbital masses using DWI and DCE MR imaging.

2. Material and methods

2.1. Patients

The institutional review board approved this prospective single-institution clinical study. Written informed consent was obtained from all patients.

Between May 2013 and July 2014 a total of 91 patients with known or suspected orbital space-occupying lesion were recruited in the outpatient ophthalmology clinic. This study was registered at clinicaltrials.gov under ClinicalTrials.gov-ID (NCT01884207). A senior ophthalmologist who is specialized on orbital tumors