Radiología. 2015;57(2):142–149

RADIOLOGÍA

www.elsevier.es/rx

ORIGINAL ARTICLE

Accuracy of magnetic resonance imaging in differentiating between benign and malignant vertebral lesions: Role of Diffusion-weighted imaging, in-phase/opposed-phase imaging and apparent diffusion coefficient☆

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Received 8 April 2013; accepted 7 November 2013

KEYWORDS
Magnetic resonance imaging;
Diffusion;
Apparent diffusion coefficient;
In-phase/ out-of-phase;
Fractures;
Vertebra;
Osteoporosis;
Metastasis

Abstract
Objective: To determine the ability of MRI to distinguish between benign and malignant vertebral lesions.
Materials and methods: We included 85 patients and studied a total of 213 vertebrae (both pathologic and normal). For each vertebra, we determined whether the lesion was hypointense in T1-weighted sequences and whether it was hyperintense in STIR and in diffusion-weighted sequences. We calculated the in-phase/out-of-phase quotient and the apparent diffusion coefficient for each vertebra. We combined parameters from T1-weighted, diffusion-weighted, and STIR sequences to devise a formula to distinguish benign from malignant lesions.
Results: The group comprised 60 (70.6%) women and 25 (29.4%) men with a mean age of 67 ± 13.5 years (range, 33–90 y). Of the 85 patients, 26 (30.6%) had a known primary tumor. When the lesion was hypointense on T1-weighted sequences, hyperintense on STIR and diffusion-weighted sequences, and had a signal intensity quotient greater than 0.8, the sensitivity was 97.2%, the specificity was 90%, and the diagnostic accuracy was 91.2%. If the patient had a known primary tumor, these values increased to 97.2%, 99.4%, and 99%, respectively.
Conclusion: Benign lesions can be distinguished from malignant lesions if we combine the information from T1-weighted, STIR, and diffusion-weighted sequences together with the in-phase/out-of-phase quotient of the lesion detected in the vertebral body on MRI.

☆ Please cite this article as: Martel Villagrán J, Bueno Horcajadas Á, Pérez Fernández E, Martín Martín S. Precisión de la resonancia magnética en la diferenciación entre lesión vertebral maligna y benigna: papel de las secuencias de difusión, del cociente fuera de fase/en fase y de los valores del coeficiente de difusión aparente. Radiología. 2015;57:142–149.

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2173-5107/$ - see front matter

PALABRAS CLAVE
Resonancia magnética;
Difusión;
Coeficiente de difusión aparente;
Fase/fuera de fase;
Fracturas;
Vértebra;
Osteoporosis;
Metástasis

Precisión de la resonancia magnética en la diferenciación entre lesión vertebral maligna y benigna: papel de las secuencias de difusión, del cociente fuera de fase/en fase y de los valores del coeficiente de difusión aparente

Resumen
Objetivo: Establecer la capacidad diagnóstica de la RM para distinguir las lesiones vertebrales benignas de las malignas.
Material y métodos: Incluimos en el estudio a 85 pacientes con un total de 213 vértebras estudiadas (tanto patológicas como normales). Para cada vértebra determinamos si la lesión era hipointensa en T1 y si era hiperintensa o no en las secuencias STIR y potenciada en difusión. Calculamos el valor del cociente fuera de fase/en fase y el valor del coeficiente de difusión aparente de cada vértebra. A partir de los parámetros T1, difusión y STIR establecimos una combinación diagnóstica de lesión maligna.
Resultados: El grupo comprendía 60 (70,6%) mujeres y 25 (29,4%) hombres con una edad media de 67 ± 13,5 años (33–90 años). De los 85 pacientes, un total de 26 (30,6%) tenían antecedentes de tumor primario. Cuando la lesión era hipointensa en las imágenes potenciadas en T1, hiperintensa en STIR y en las imágenes potenciadas en difusión, y con un cociente de intensidad de señal mayor de 0,8, la sensibilidad fue del 97,2%; la especificidad del 90% y la exactitud diagnóstica del 91,2%. Si el paciente tenía un tumor primario conocido, los valores se incrementaron hasta el 97,2; 99,4 y 99%, respectivamente.
Conclusión: Es posible distinguir las lesiones benignas de las malignas si valoramos de forma conjunta la señal en T1, STIR y difusión y el cociente fuera de fase/en fase de la lesión detectada con RM en el cuerpo vertebral.

Introduction

Computed tomography (CT) and magnetic resonance (MR) are the most useful modalities to perform differential diagnoses of one vertebral lesion and are available in most hospitals. Determining the benign or malignant nature of one vertebral lesion is not always possible. It is especially hard to know if the oncologic patient's pathologic tears are osteoporotic or metastatic. Some purely morphologic characteristics show some sensitivity, specificity and diagnostic accuracy >90% both in the CT[1] and the MR.[2,3] This is no obstacle for the diagnosis of a far from negligible percentage of lesions to require more sophisticated tests – even biopsies. During the last years several articles have been published on the use of MR sequences like phase/out-of-phase[4–9] studies, diffusion-weighted sequences[10–18] or the apparent diffuse coefficient (ADC)[19–22] in an effort to try to better distinguish one benign vertebral lesion from a malignant one. The outcomes of these studies are not completely clear and show some discrepancies. On the other hand most have focused on establishing the difference between osteoporotic and metastatic tear.

The goal of our study was to determine the diagnostic capability of MR to distinguish between benign and malignant vertebral lesions by assessing the combination of signal characteristics in T1, STIR, diffusion-weighted sequences; out-of-phase/in-phase signal correlation coefficient, and the ADC.

Materials and methods

Patients

Between March 2011 and September 2012 we prospectively included 85 patients with a clinical presentation of acute back pain who underwent one dorsal or lumbar spine MRI to discard vertebral fracture. The decision to include a patient was made after acquiring and reviewing immediately the sagittal T1-weighted sequence. If one vertebra was seen showing one hypointense (signal, focal or diffuse alteration exactly the same or lesser than that of the muscle) or hyperintense lesion (signal, focal or diffuse alteration similar to that of subcutaneous fat) the full protocol of sequences and measurements was activated. Such protocol was also implemented when in the presence of morphologic alteration of the vertebral body (wedging >25%). In the T1-weighted sequences not only lesions suspicious of malignancy were included but also any hypo or hyperintense lesions as well. In each and every patient one normal vertebra (without morphologic alterations or hypo or hyperintense lesions) and one, two or three pathologic vertebrae, including one variable number of pathologic vertebrae depended on the number of vertebrae showing lesions in one single patient. The total number of vertebrae studied (both pathologic and normal) was 213 that is an average 2.5 vertebrae per patient. The ultimate diagnosis of each lesion was established through the different image modalities (X-ray, ultrasound, CT, MR, PET–CT), analyses and clinical evolution. For example in patients with metastasis the presence of similar lesions in other vertebrae, high tumor markers and the patient's oncologic history allowed us to reach the diagnosis very precisely. Besides these criteria 6-month-follow up was added in all patients to guarantee the stability both in the number and characteristics of the lesion. In 6 cases it was necessary to perform biopsies.

All patients signed the informed consent that is usually handed out and one spinal cord MR is performed. It was not necessary to include special consent or the approval from the ethical committee since the protocol implemented