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Diagnostic value of diffusion-weighted magnetic resonance imaging: differentiation of benign and malignant lymph nodes in different regions of the body☆

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ABSTRACT

Introduction: To evaluate the value of diffusion-weighted magnetic resonance imaging compared with conventional magnetic resonance imaging (C-MRI) for the differentiation of benign from malignant lymph nodes in different regions of the body.

Patients and methods: A total of 31 patients ranging in age from 18 to 75 years (mean age: 53 years) were included in this study. The patients were examined using a 1.5-T magnetic resonance imaging system with coils chosen according to lymph node locations. Diffusion-weighted images were obtained using the single-shot echo planar sequence and had *b* values of 50, 500, and 1000 s/mm$^{2.}$ The apparent diffusion coefficient (ADC) values were measured from ADC maps. The correlation between the pathological diagnoses and mean ADC values in the benign and malignant lymph node groups were compared using the Mann–Whitney *U*-test with Bonferroni correction. Receiver operating characteristic (ROC) analysis was performed to evaluate the diagnostic performance of the method.

Results: The mean ADC value for benign lymph nodes was 0.97×10^{-3} mm^2/s (range: 0.6–1.2×10^{-3} mm^2/s), and the mean ADC value for malignant lymph nodes was 0.76×10^{-3} mm^2/s (range: 0.3–1.2×10^{-3} mm^2/s) ($P<.001$). In ROC analysis, the cut-off ADC value for malignant versus benign lymph node differentiation was 0.8×10^{-3} mm^2/s. Using an ADC value of 0.8×10^{-3} mm^2/s, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the method for differentiating between benign and malignant lymph nodes were 76.4%, 85.7%, 86.6%, 75%, and 80.6%, respectively. The sensitivity, specificity, PPV, NPV, and accuracy of C-MRI were 88.2%, 78.5%, 83.3, 84.6%, and 83.8%, respectively. The sensitivity, specificity, PPV, NPV, and accuracy of C-MRI findings suspicious for malignancy combined with the ADC values were 76.4%, 64.2%, 100%, 81.8%, and 91.6%, respectively.

Conclusions: C-MRI alone remained superior to diffusion-weighted imaging (DWI) and combination C-MRI and DWI for differentiating malignant from benign lymph nodes; however, DWI and ADC calculation may play a role in lymph node characterization.

1. Introduction

Determination of the nature of lymph nodes is crucial for the staging, treatment planning, and follow-up of malignancies [1,2]. The parameters used for conventional methods to diagnose malignant lymph nodes are size, shape, extracapsular extension, and central necrosis; however, these criteria have potential limitations [3]. Metabolic imaging with single photon emission computed tomography and positron emission tomography can help with differentiation but are expensive, less available, and low in spatial resolution [4–6]. Fine-needle aspiration biopsy guided by ultrasonography has been shown to be an important method for differentiating malignant lymph nodes from benign ones; however, the modality is invasive and operator dependent with a high incidence of false-negative results [7–10].

Diffusion-weighted magnetic resonance imaging (DW-MRI) is a non-invasive functional technique that analyzes tissue microstructure based on the random diffusion of water molecules. Cellularity is the main factor restricting diffusion. The movement of water molecules in biological tissues is restricted because of their interaction with cell membrane and macromolecules. The increased number of cells, increased nucleocytoplasmic ratio, and decreased extracellular space in malignancy limit water diffusion [11]. The apparent diffusion coefficient (ADC) map obtained from DW-MRI shows the measure of water diffusion and allows tissue characterization by quantitative analysis [12–17].

☆ There is no conflict of interest.

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Table 1
Pulse sequence parameters for the cervical region

	T1-weighted	T2-weighted FSE	Diffusion-weighted	T1-weighted fat-suppressed contrast-enhanced
Parameter				
Matrix size	256×256	256×256	256×256	256×256
Slice thickness (mm)	7	7	5.5	7
Section gap (mm)	2	2	2	2
Repetition time (ms)	600	4100	5000	600
Echo time (ms)	8	80	90	8
FoV (mm)	280×280	280×280	280×280	280×280

Note: FSE, fast spin echo; FoV, field of view.

The purpose of our study was to evaluate the diagnostic value of DW-MRI compared with conventional magnetic resonance imaging (C-MRI) for the differentiation of malignant and benign lymph nodes in different regions of the body.

2. Patients and methods

2.1. Patients

This prospective study was performed between September and December 2012 after approval of the institutional ethics committee.

In each patient, the largest node was selected for evaluation. Lymph nodes that had a long-to-short diameter ratio (L/S)<2 and short diameter≥10 mm were considered suspicious for malignancy on C-MRI (18 patients, 58%) [18]. All patients who had suspicious malignant lymph nodes on C-MRI also had a primary malignant disease. Lymph nodes with central necrosis and extracapsular extension were detected in two patients. These two lymph nodes also had other criteria suspicious for malignancy (L/S<2, short diameter≥10 mm) on C-MRI. Lymph nodes lacking these features were considered benign (13 patients, 41%).

Thirty-one patients (14 males and 17 females) with a mean age of 53.1±11.8 years (age range: 18–75 years) were included in our study. Twenty-three patients (74.1%) underwent excisional lymph node biopsy. The lymph nodes of three patients (9.6%) were considered metastatic (malignant), and those of five patients (16.1%) were considered benign (oval shape, L/S>2 or short diameter<10 mm).

Although 22 patients (70.9%) had a primary malignant disease, there were no primary malignancies in nine patients (29.1%). In these patients, 15 lymph nodes (48%) were located in the axillary; 10 (32%), in the cervical; and 6 (19%), in the perivascular (para-aortic, para-iliac, and inguinal) regions.

Twenty-three patients (74.1%) underwent excisional lymph node biopsy (8 males and 15 females; mean age: 48.82 years; range: 18–64 years). Nineteen of these patients (82.6%) had a primary malignancy (11 with breast carcinoma, 3 with lymphoma, 2 with malignant melanoma, 2 with nasopharynx carcinoma, and 1 with renal cell carcinoma). There were no primary malignancies in the remaining four patients (17.3%). These lymph nodes were located in the axillary (15 lymph nodes), cervical (5 lymph nodes), and inguinal (3 lymph nodes) regions.

Three patients (9.6%) with a history of primary malignancy who did not require a biopsy due to the advanced stage of the malignancy were also included in the study (three males; mean age: 58 years; range: 34–75 years). In these three patients, who had prostate carcinoma, renal cell carcinoma, and embryogenic testis carcinoma, respectively, those lymph nodes that met the following malignancy criteria were considered metastatic: size (mean long-to-short diameter: 43.3±15.2 to 31.6±16.0 mm), round shape, extracapsular extension (two lymph nodes), and central necrosis (two lymph nodes) [13]. These lymph nodes were located in the para-iliac and para-aortic (two lymph nodes) regions (regional lymphatic drainage way).

An additional five patients (16.1%) (three males and two females; mean age: 41.40 years; range: 33–50 years) with no primary malignancies and who had lymph nodes owing to benignity criteria (oval shape,

Table 2
Pulse sequence parameters for the axillary region

	T1-weighted	T2-weighted FSE	Diffusion-weighted	T1-weighted fat-suppressed contrast-enhanced
Parameter				
Matrix size	256×256	256×256	256×256	256×256
Slice thickness (mm)	4	4	4	4
Section gap (mm)	0.5	0.5	0.5	0.5
Repetition time (ms)	580	400	4000	580
Echo time (ms)	4	60	60	4
FoV (mm)	280×280	280×280	280×280	280×280

Note: FSE, fast spin echo; FoV, field of view.

Table 3
Pulse sequence parameters for the abdominal region

	T1-weighted	T2-weighted FSE	Diffusion-weighted	T1-weighted fat-suppressed contrast-enhanced
Parameter				
Matrix size	256×256	256×256	256×256	256×256
Slice thickness (mm)	10	10	9	10
Section gap (mm)	2.5	2.5	1.5	2.5
Repetition time (ms)	120	650	3500	120
Echo time (ms)	4	60	60	4
FoV (mm)	280×280	280×280	280×280	280×280

Note: FSE, fast spin echo; FoV, field of view.