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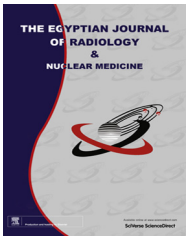

ORIGINAL ARTICLE

Can diffusion weighted image and apparent diffusion coefficient (ADC) differentiate benign from malignant cervical adenopathy?

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KEYWORDS

Diffusion weighted image (DWI);
Apparent diffusion coefficient (ADC);
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Abstract *Background:* Cervical adenopathy is a common problem and the differentiation of benign and malignant node is of crucial importance for therapy management.
Objective: This prospective study aimed to know if Diffusion weighted images (DWI) and apparent diffusion coefficient (ADC) can differentiate benign from malignant cervical lymphadenopathy.
Patients and methods: Thirty patients with cervical adenopathy were included in this study. Doppler ultrasound, DWI and ADC maps were automatically reconstructed and used for the measurement of ADC values.
Results: The sensitivity and specificity of the RI cut-off value <0.69 in differentiation between benign and malignant cervical L.Ns was 88.8% and 71.4%, respectively. The optimal ADC cut off value for differentiation between benign and malignant lymph nodes was $\leqslant 1.0\times10^{-3}$ mm^2/s with an accuracy 96.7%, a sensitivity 100%, a specificity 88.9%, PPV 95.4% and NPV 100% and statistically significant *P*-value = 0.000.
Conclusion: DWI and ADC were useful for differentiation between benign and malignant cervical lymphadenopathy and recommended to decrease the need of invasive biopsies. However, CDUS

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techniques can be used as preliminary technique but, they had potential pitfalls in diagnosis of malignant cervical lymphadenopathy cases.

1. Introduction

Cervical lymph nodes are prone to be involved in a number of pathologic processes. They are common sites for lymphoma, metastasis, and reactive enlargement in a number of conditions including tuberculosis (TB) (1).

Differentiation between benign and malignant lymph nodes usually changes the prognosis of the patient and plays a crucial role in planning the therapy of malignancy suspected patients (2). However, the differentiation between benign and malignant lymph nodes remains challenging (3).

Color Doppler ultrasound has been proposed as a method of differentiating benign from malignant lymphadenopathy, as it is a sensitive non-invasive imaging technique capable of detecting vessels as small as those found in lymph node (4).

Diffusion-weighted MR imaging (DWI) is a non invasive functional technique and valuable tool for the identification and characterization of lymph nodes; it highlights both normal and pathologic lymph nodes and enables measuring diffusion in lymph nodes by means of the so-called apparent diffusion coefficient (ADC) (5). Therefore DWI can be helpful in distinguishing between causes of cervical lymphadenopathy (6,7).

Normal lymph nodes have a relatively restricted diffusion (low ADC) because of their high cellular density. Metastatic lymph nodes may have increased cellular density or necrotic areas, which further restricts or increases diffusion, respectively (8,9).

1.1. The aim of this work

The aim of the work is to evaluate the role of DWI and ADC in differentiating benign from malignant cervical lymphadenopathy, preliminary evaluated with Doppler US.

2. Patients and methods

Thirty consecutive patients presenting with enlarged neck lymph nodes were included in this prospective study, during the period from January 2012 and March 2013. Their age ranged from 11 to 65 years (mean age was 38.5 years), 21 were males while only 9 female cases were found. Patients were referred to MRI unit of the Zagazig university hospitals after clinical detection of enlarged cervical L.N groups. Only 6 cases had signs of inflammation. Inclusion criteria: patient presented with cervical lymphadenopathy regardless of age or sex. Cases with previous surgery or radiotherapy were excluded. Written informed consent was obtained from all patients and the study was approved by local ethics committee. All cervical L.N groups were involved in this study, one L.N was examined in 20 cases, 2 L.Ns were examined in the other 10 cases. The final suggested diagnosis was made by three radiologists. They were aware of the clinical data, then the imaging findings were correlated with the pathological data. The patients with neck nodal disease underwent the following:

(1) *Clinical assessment:* Full history and clinical examination: of the enlarged L.Ns, performed by referring physicians.

(2) *Grey scale and color Doppler ultrasound examination:* Gray scale and Doppler sonography using linear transducer (frequency 7.5 MHz) at ultrasound system of Logic3 expert.

(A) Grey scale ultrasound examination: the largest lymph nodes were assessed for the Size: Long and short axis diameters were measured. *Shape:* The shape of the lymph node was determined by the short axis to long axis ratio (S/L). A S/L ratio less than 0.5 indicates a long or oval node, whereas greater than or equal to 0.5 indicates a round node. *Nodal hilum:* wide, narrow or absent. *Echogenicity:* hypoechoic, hyperechoic or isoechoic. *Homogenicity:* homogenous or heterogeneous. *Nodal border:* either well or ill defined border. *Ancillary features:* including cystic necrosis, calcification, matting and surrounding soft tissues.

(B) Color Doppler ultrasound examination: If a vascular signal was detected in a node (hilar, peripheral, mixed, intranodal dots), spectral Doppler was performed to measure the vascular resistance. The sample volume was standardized to 1 mm and was placed in the center of the vessel. Angle correction was made at an angle of 60 or less in all examinations.

Each measurement of RI was obtained from three consecutive Doppler spectral waveforms or from the clearest arterial signal.

(3) MR imaging:

All patients were examined on 1.5T Philips superconducting MR imager (Achieva, class IIa, USA).

1. Conventional non contrast MR imaging: Preliminary to the diffusion weighted magnetic resonance imaging, including Axial T1WI and T2WI.
2. Diffusion weighted magnetic resonance imaging:

- Single-Shot Echo-planar diffusion sensitized sequences (DWI) (TR 3.4 s, TE 99 ms, Matrix 512 × 512, slice-thickness 4 mm with an interslice gap of 1 mm and FOV 230 mm) were acquired on the axial plane.
- The diffusion-sensitizing gradients were applied with a *b* factor of 0 and 1000 s/mm^2 per axis in each patient. The *b*-value used in this study has been determined by the specifications of the MR-scanner and the image quality. There is no unique *b*-value established for DWI of lymph nodes yet. ADC maps were automatically reconstructed for all diffusion-weighted images and used for the measurement of ADC values.

(C) Imaging data analysis

Isotropic diffusion images with $b = 1000$ s/mm^2 were generated from the three diffusion directions assessed. Trace ADC maps were generated automatically.