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REVIEW

Usefulness of diffusion-weighted imaging and the apparent diffusion coefficient in the assessment of head and neck tumors

Apport de l'imagerie de diffusion et du coefficient de diffusion apparent pour l'étude des tumeurs de la tête et du cou

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MOTS CLÉS
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Coefficient de diffusion apparent ;
Tumeur ;
Tête et cou

Summary The aim of this review was to determine the usefulness of diffusion-weighted imaging (DWI) and the apparent diffusion coefficient (ADC) in the assessment of head and neck tumors. DWI and the ADC can help in the differential diagnosis of particular disorders (such as carcinomas vs lymphomas, or necrosis vs abscess) of the head and neck. The ADC can also provide further information to help differentiate benign from malignant tumors, as ADC values are usually lower in cases of malignancy. However, the ADC is itself influenced by various complex factors such as the cellularity and matrix of tumors and there is also some overlap between certain benign and malignant tumors of the salivary glands.

Résumé L'objectif de cette revue est de montrer l'intérêt de l'imagerie de diffusion (DWI) et du coefficient de diffusion apparent (ADC) pour l'étude des tumeurs de la tête et du cou. DWI et ADC sont utiles pour le diagnostic différentiel de certaines entités (carcinomes vs lymphomes, nécrose vs abcès) de la tête et du cou. L'ADC peut également apporter des information sur la différenciation entre tumeurs bénignes et malignes, les valeurs d'ADC étant généralement plus basses en cas de tumeurs malignes. Cependant, l'ADC est influencé par plusieurs paramètres complexes tels que la cellularité et la matrice tumorale et des chevauchements existant entre certaines tumeurs bénignes et malignes des glandes salivaires.

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Introduction

Diffusion-weighted imaging (DWI) is used to evaluate the rate of microscopic water diffusion within tissues. Although DWI is known to be of great value in stroke, this method has also been used to evaluate tumors of the central nervous system [1—4]. Indeed, the results of studies comparing the apparent diffusion coefficient (ADC) to histopathological findings in tumors have strongly suggested that greater cellularity is associated with a more restricted diffusivity [3,4].

More recently, DWI has been applied to the head and neck regions [5—23]. Reportedly, DWI may be useful for characterizing head and neck tumors and help to differentiate among particular tumors and between benign and malignant ones, based on ADC assessment [5,8,9,16—18]. We have proposed the application of line-scan DWI (LSDWI) in the head and neck because this technique has proven to be relatively free of susceptibility artifacts [15,21,22,24—29]. In this article, we describe the LSDWI method and review the usefulness of DWI scans and the ADC for characterization of head and neck tumors.

DWI techniques for head and neck lesions

Several DWI techniques have been proposed for the evaluation of head and neck lesions. Echoplanar DWI (EPDWI) has generally been used despite its susceptibility to artifacts in the head and neck regions [5—14,16—20,23]. According to some investigators, 16% of their cases showed local distortions that affected the lesions on single-shot EPDWI scans obtained with a *b* factor of 1000 s/mm^2; their ADC maps were also suboptimal because of susceptibility artifacts [5]. More recently, a parallel-imaging technique has been used to avoid susceptibility artifacts on EPDWI images, resulting in acceptable EPDWI and ADC images of lesions close to the airways [20]. Another DWI technique is the application of

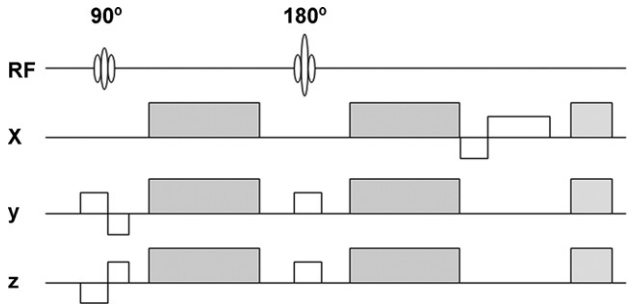

Figure 2 The line-scan DWI (LSDWI) sequence chart.
Figure 2 Schéma de la séquence de diffusion à balayage de lignes (LSDWI).

LSDWI [15,21,22]. As this technique is inherently insensitive to susceptibility artifacts, it appears to be eminently suitable for the evaluation of diffusivity of head and neck lesions (Fig. 1).

Principles and methods of line-scan DWI

To create a two-dimensional image, LSDWI uses multiple diffusion-weighted spin-echo column excitations. Fig. 2 shows that the basic sequence comprises spatially selective 90° and 180° pulses. The LSDWI image comprises a series of one-dimensional magnitude profiles obtained from parallel columns lying in the image plane. Each column is formed by the intersection of two slices that are selected by the two-slice selective radio frequency (RF) pulses. This excitation scheme (Fig. 3) allows rapid repetition of the excitation without spin saturation. The fundamental principle of the scheme is to avoid alignment of the slices excited by the selective pulses with the imaging plane. The selected planes are positioned such that the volume at their intersection forms the column of interest in the imaging plane. For optimal coverage, the columns overlap slightly and column

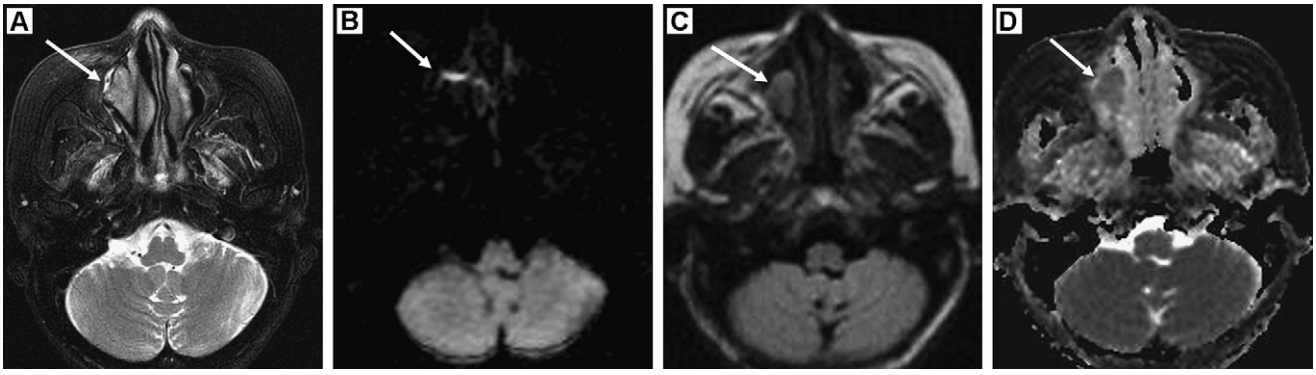

Figure 1 In a 64-year-old woman with malignant melanoma: A: T2-weighted fat-suppression image shows a tumor in the right maxillary sinus (arrow); B: echoplanar DWI ($b = 1000$ s/mm^2) shows a prominent susceptibility artifact (arrow), resulting in image degradation; C: line-scan DWI ($b = 1000$ s/mm^2) reveals the tumor without susceptibility artifacts (arrow); D: the ADC map shows values within the tumor (arrow) to be lower (mean: 0.98×10^{-3} mm^2/s) than those of adjacent structures.
Figure 1 Mélanome malin chez une femme âgée de 64 ans : A : l'image pondérée T2 avec suppression de graisse montre une tumeur du sinus maxillaire droit (flèche) ; B : l'imagerie de diffusion échoplanar ($b = 1000$ s/mm^2) montre un artéfact de susceptibilité (flèche) responsable d'une dégradation de l'image ; C : l'imagerie de diffusion à balayage de lignes ($b = 1000$ s/mm^2) montre la tumeur sans artéfacts (flèche) ; D : la cartographie ADC montre des valeurs d'ADC de la tumeur plus basses (flèche) que celles des structures adjacentes. La valeur moyenne de l'ADC du mélanome est $0{,}98 \times 10^{-3}$ mm^2 par seconde.