ORIGINAL ARTICLE

Value of apparent diffusion coefficient and magnetic resonance spectroscopy in the identification of various pathological subtypes of parotid gland tumors

Alsiagy A. Salama [a],[1],[*], **Ahmed Hussieny El-Barbary** [b], **Mohamed Ali Mlees** [c], **Ghada El- Sayed Esheba** [d]

[a] *Radiodiagnosis & Imaging Department, Faculty of Medicine, Tanta University, Egypt*
[b] *Unit of Vascular Surgery, General Surgery Department, Faculty of Medicine, Tanta University, Egypt*
[c] *Unit of Surgical Oncology, General Surgery Department, Faculty of Medicine, Tanta University, Egypt*
[d] *Department of Histopathology, Faculty of Medicine, Tanta University, Egypt*

Abstract *Background and purpose:* Pre-operative imaging has a major role in surgical planning of parotid gland tumors.
Aim: To assess the role of the combined techniques of ADC generated from DWI and MR spectroscopy in identification of various pathological subtypes of parotid gland tumors.
Patients and methods: Prospective study was conducted on 25 patients with primary parotid tumors (11 males, 14 females, age ranged 22–79 years with mean of 53.4 ± 13.6 years). DWI and MRS were performed for all patients and the results were correlated with histopathological findings.

Results: The 18 (72%) benign and 7 (28%) malignant tumors consisted of 11 pleomorphic adenomas, 7 Warthin tumors, and 7 malignant tumors. The mean ADC value for pleomorphic adenomas was $1.89 \pm 0.18 \times 10^{-3}$ mm^2/s, for Warthin tumors was $0.92 \pm 0.22 \times 10^{-3}$ mm^2/s, and for the malignant tumors was $1.03 \pm 0.13 \times 10^{-3}$ mm^2/s, significant difference was seen between benign and malignant tumors ($P = 0.037$). The mean values of Cho/Cr ratios were 3.37 ± 0.78, 5.9 ± 1.75 and 1.72 ± 0.41, for pleomorphic adenomas, Warthin tumors, and malignant tumors, respectively. Difference was significant between benign and malignant tumors ($P = 0.001$).
Conclusion: DWI and MRS are useful noninvasive diagnostic modalities in identification of various pathological subtypes of parotid tumors.

1. Introduction

Salivary gland neoplasms represent the most complex and diverse group of tumors encountered by the head and neck oncologist. Their diagnosis and management are complicated by their relative infrequency (3% of head and neck tumors) (1). However, the great variety of histological types makes them a major challenge for radiologists and clinicians (2).

Fine-needle aspiration cytology (FNAC) is a minimally invasive procedure used in the preoperative diagnosis of parotid gland tumors; however the results of FNAC are not always conclusive because insufficient specimens are sometimes obtained because of a small sample size or because of the deep location of the tumor (3,4). Therefore, pre-operative imaging has a major role in surgical planning (2).

CT and MRI are the usual investigations used for evaluating known or suspected salivary gland masses. Imaging cannot distinguish between different histologic types as all tumors are isoattenuating to glandular parenchyma on CT and hypointense to gland on T1 W MR image and all of them enhance on post contrast CT and MR images. However, both the modalities can sensitively differentiate between solid and cystic lesions (5).

New magnetic resonance imaging (MRI) techniques such as diffusion weighted imaging (DWI) and proton magnetic resonance spectroscopy (^{1}H-MRS) have shown promising results in the differentiation between benign and malignant salivary gland tumors (6,7).

Diffusion-weighted imaging (DWI) with magnetic resonance relies upon the relative diffusivity of water protons within the tissue. This technique is based on the amount of random (Brownian) motion that water protons undergo (8). Celebi et al., concluded that DW-MRI may be useful for distinguishing between pleomorphic adenomas and other parotid masses (9).

In normal tissue or in areas exhibiting vasogenic edema, the motion of water molecules is not limited and no restricted diffusion should be noted. In tissues with cytotoxic edema or in highly cellular regions, however, there is a diffusion restriction, which can be measured both qualitatively and quantitatively (10). Hypercellular tissue, as occurring within malignant tumors, will show low ADC values. Non-tumoral tissue changes such as edema, inflammation, fibrosis and necrosis are expected to show low cellularity, in strong contrast with viable tumor, this results in high ADC values. An inverse correlation between the ADC value and tumor cellularity in experimental models has been shown, and this was clinically validated (11,12).

Eida et al., (13) studied ADC mapping of salivary gland tumors and concluded that ADC can provide preoperative tissue characterization of salivary gland tumors.

The use of proton MR spectroscopy as a differentiating tool as a general, based upon the idea that a high Cho/Cr ratio is tied to a high cellular membrane turnover in malignant lesions. Typical spectral patterns associated with cancer include an increase in the total choline (Cho, 3.2 ppm) signal intensity (SI) relative to creatine (Cr, 3.02 ppm), often coupled with the presence of other metabolites, including lactate (Lac, 1.3 ppm) (14,15).

Choline and its derivatives are thought to originate from phospholipid metabolism of cell membranes. The finding of higher Choline metabolite levels indicates an increase in cell proliferation and membrane biosynthesis in tumors. Similar results have been obtained from prostate, brain, colon, breast, thyroid, adrenal and neck masses and it is possible that it can be used as a marker for active cellular proliferation. (16-18)

2. Aim of the work

The purpose of this study was to assess the role of the combined techniques of apparent diffusion coefficient (ADC) generated from diffusion-weighted magnetic resonance imaging (DWI) and metabolite spectrum acquired by magnetic resonance spectroscopy (MRS) in the identification of various pathological subtypes of parotid gland tumors.

3. Patients and methods

3.1. Participants

This prospective study was conducted in accordance with the recommendations of the local ethics committee of Tanta University that approved it. Written informed consent was signed by all the included patients. Between February 2013 and May 2014, 25 (25) consecutive patients (11 males, 14 females; aged from 22 to 79 years; mean age was 53.4 ± 13.6 years) with a clinically suspected primary tumor of the parotid gland were examined prospectively before surgery. Before MR imaging, all patients underwent ultrasonography to confirm the suspected clinical diagnosis. As part of the study protocol, none of the included patients had fine-needle aspiration biopsy (FNAB) before MR imaging to avoid disturbance of the lesion metabolites by hemorrhage or trauma.

Patients were referred to the MRI unit at the Tanta university hospital from the General Surgery Department. All tumors were