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ORIGINAL ARTICLE

Accuracy assessment of combined diffusion weighed and dynamic gadolinium MR sequences in characterization of salivary gland tumors

Lamya Eissa [a,*], Shadia Abou Seif [a], Salah El Desooky [a], Mohamed Eid [a], Tarek Koraitim [b]

[a] *Radiology Department, Alexandria University, Egypt*
[b] *Head and Neck Surgery Department, Alexandria University, Egypt*

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KEYWORDS

Diffusion;
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Abstract *Background:* The salivary glandular tumors are challenging as regards preoperative diagnosis and MRI with the use of DWI and DCE are evaluated in accuracy for characterization of salivary masses.
Methods: The study included 53 patients who underwent MRI-DWI and DCE and diagnosis was made by diagnostic scheme of ADC-values and four types of DCE curves.
Results: Pleomorphic adenomas had the highest of all ADC values on DWI ($\geqslant 1.4 \times 10^{-3}$ cm^2/s), and Warthin tumors had low values ($0.6–0.8 \times 10^{-3}$ cm^2/s), while malignant tumors had intermediate values ($0.8–1.2 \times 10^{-3}$ cm^2/s). Type A curve predominated the pleomorphic adenomas, type B curve predominated Warthin, and other lymphoid lesions as lymphoma. Type C curve predominated malignant lesions. Statistical analysis showed combination intermediate ADC (in range of 0.8 to $< 1.4 \times 10^{-3}$ cm^2/s) and type C as useful test of malignancy with high accuracy of 90.5%.
Conclusion: DWI and dynamic enhancement curves with combined interpretation of both techniques and in view of the concluded values can provide valuable data in characterization of salivary glandular tumors.
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1. Introduction

Salivary gland tumors account for only 3% of all tumors in the body and it is estimated that about 1% of all head and neck malignant neoplasms arise in the salivary glands (1–3). However, the great variety of histological types makes them a major challenge for radiologists and clinicians. Fine needle aspiration cytology (FNAC) is not always conclusive; there is a selection bias and when the tumor is located in the deep lobe, FNAC cannot be performed in all cases. Therefore, preoperative imaging has a major role in surgical planning (2,3). Conventional MRI imaging of these lesions had shown some suggestive features; T2 bright signal and polylobulation have

* Corresponding author.
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suggested pleomorphic adenoma, and T2 hypo-intensity and cystic changes favored Warthin, while diagnosis of malignant tumors may be suggested in case of high-grade lesions with infiltrative margins. However, conventional features alone cannot adequately characterize parotid lesions. The purpose of this work was to evaluate the potential use of dedicated MRI sequences of diffusion and dynamic curves in preoperative characterization of salivary glandular tumors.

2. Patients, materials and methods

2.1. Patient population

This study was conducted in accordance with the local ethics committee and included 53 patients, presented to our Radiology Department in a prospective study in the period from July 2013 to January 2015.

The patients had clinically palpable lesions of the major salivary glands suspected to be tumors and imaging was requested for the aim of diagnosis and local staging purpose.

The parotid lesions constituted the majority, contributing 45 out of the total 53 cases, with single case of submandibular, two cases of minor salivary glands (palate and floor of mouth) and 5 parotidectomies.

The study included 28 females and 25 males with age range from 20 to 75 years (pediatric age <18 have been excluded).

Following DW-MRI, 47 masses were surgically biopsied or resected (36 parotidectomies, 8 enucleation, excision of palatal, floor of sublingual and submandibular lesions), 3 were cytologically analyzed via US-FNAC, and 2 had nodes assessed by nodal FNAC or excision. CT chest in one case of parotid deposit showed primary bronchogenic carcinoma.

2.2. MRI technique and methods

The MRI examination studies were made on closed 1.5 Tesla magnets (Siemens; Avanto, Germany).

Dedicated multichannel head and neck coil has been used. Our Neck MRI exam included the following sequences: Axial T1 turbo spin echo (TSE) Without Fat suppression, Axial T2 Turbo-spin echo with fat suppression, and axial and Coronal T2 sequence without fat suppression.

- For routine sequences a slice thickness of 5 mm was used with inter-slice gap of 3 mm, and a 16×16 cm field of view (FOV), with 2 averages used. Spin echo T1 weighted images used (TR, 400 ms; TE, 10 ms; 256×256 matrix), turbo spin-echo T2 weighed (TR, 4400 ms; TE, 105 ms; 250×250 matrix).
- First diffusion images are taken before injection of contrast. These diffusion images use single shot spin echo planar imaging (SS-EPI) in axial plane, with fat suppression made by chemical shift selective fat suppression. Diffusion was obtained by "High" repetition time (TR) 1700 ms, "short" echo time (TE) 100 ms, "Coarse" matrix, 192×144; slice numbers, 30; slice thickness = 5 mm; interslice gap, 35%; FOV, 25 cm; averages, 5; acquisition time approximately 1 min 45 s. "Three b-factors " are obtained including 0, 500 and 1000 s/mm^2 in the axial plane.
- Following diffusion, dynamic MRI sequence was made by injection of Gadolinium Gadopentate Dimeglumine with a dose of 0.1 mmol/kg and at a rate of 2 ml/s using power injector followed by 20 ml saline flush. Sequential images were obtained through the lesion in axial plane and at different time intervals (at 30, 60, 90, 120, 150, 180, 240 and 300 s following injection). Following dynamic acquisition, conventional post contrast MRI images are acquired in the axial, sagittal and coronal planes.

2.3. Image analysis

2.3.1. Image analysis of diffusion images

A region of interest (ROI) was drawn on the tumor by two experienced head and neck radiologists (more than 8 years experience in Head and Neck Radiology). This ROI is drawn on solid portion of the tumor. It must be sufficient, at least 1/2 of the tumor cross-sectional area in given axial slice. Areas of hemorrhage or necrosis are avoided.

2.3.2. Post processing and image analysis for DCE-MRI

The time–intensity curves were generated on dedicated Siemens software after drawing the ROI on the lesion, which covers the solid enhancing portion of the lesion. Vessels, necrosis, calcifications and hemorrhages are avoided. Sufficient ROI must be obtained (at least 50% of cross-sectional area). Dynamic enhancement curves are described according to Yabuuchi et al. (4) in Fig. 1 and diagnosis is made according to scheme in Fig. 2.

2.4. Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20 (2). The distributions of quantitative variables (ADC-values) were tested for normality using Kolmogorov–Smirnov test. For abnormally distributed data Kruskal Wallis test was used to compare between different groups and Mann–Whitney Test was assessed for pair-wise comparisons. Receiver operating characteristic curve (ROC) was plotted to analyze a recommended cutoff, and the area under the ROC curve denotes the diagnostic performance of the test. Area more than 50% gives acceptable performance and area about 100% is the best performance for the test. Significance of the obtained results was judged at the 5% level (see Figs. 3–9).

3. Results

3.1. Patients demographics and general distribution of histopathological lesions

Age and sex demographics showed 28 females and 25 males with age range from 20 to 75 years. The parotid lesions constituted the majority, contributing 45 out of the total 53 cases, with single case of submandibular, two cases of minor salivary glands (palate and floor of mouth), and 5 parotidectomy cases (Table 1).

As expected benign lesions took the upper hand overall 41 out of 53 cases with benign pathology (constituting 77.4%) against 12 cases of malignant pathology (constituting 22.6%). Benign mixed tumor represented the most common tumor ($n = 21$) and represented 63% of benign lesions and

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