ORIGINAL ARTICLE

Value of dynamic contrast enhanced magnetic resonance imaging in the differentiation between post-treatment changes and recurrent salivary gland tumors

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Sieza Samir [a], Mohamed Ali El-Adalany [a],*, Emad Eldeen Hamed [b]

[a] Diagnostic Radiology, Faculty of Medicine, Mansoura University, Egypt
[b] Surgical Oncology, Oncology Center, Mansoura University, Egypt

Abstract   *Purpose:* The purpose of this study was to investigate the diagnostic value of dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) in the differentiation between post-treatment changes and recurrent salivary gland tumors. *Patients and methods:* A prospectively designed study was conducted on 37 patients having salivary gland malignant tumors treated by surgery or chemo/radiotherapy or both. All patients underwent conventional MRI and DCE-MRI. The obtained DCE-MRI data were interpreted semi quantitatively (using time intensity curves, TIC and time to peak TTP) and quantitatively (using wash in and washout rates). The obtained TICs were classified into four types (A, B, C, and D). *Results:* There was a significant statistical difference as regards TICs, wash in and washout rates of recurrent salivary gland tumors and that of post treatment changes, whereas there was no significant difference as regards TTP. Receiver Operating Characteristic (ROC) analysis revealed cutoff points of > 10.25, and > 6.25 for the wash in and washout rates used to differentiate recurrent tumors from post-treatment changes, respectively. *Conclusion:* We concluded that DCE MRI has a valuable diagnostic value in the differentiation of recurrent malignant salivary gland tumors from post-treatment changes, especially, for cases that remain unsolved by conventional MR imaging techniques.

1. Introduction

The management of head and neck cancer involves multidisciplinary evaluation and treatment. Often tumor recurrence may

not be evident clinically until the recurrence is large enough to be clinically palpable, and hence imaging plays an important role in the post-treatment surveillance of head and neck cancers. Differentiating post-treatment changes from tumor recurrence with the use of imaging is challenging because of the presence of altered anatomy secondary to resection and post-surgical scarring. Furthermore, radiation therapy may induce tissue distortions such as edema, inflammation, and fibrosis,

which makes post-treatment images more difficult to interpret [1].

Conventional post-contrast MRI is currently used for differentiating recurrent tumor from fibrosis after treatment of head and neck cancer. Although the anatomical information derived from the conventional post-contrast MRI is valuable morphologically, it lacks functional information. Hence, the recent advances in head and neck imaging are shifting from the morphological to the functional techniques, which are used to assess the complex related processes in the cancer microenvironment such as hypoxia, and angiogenesis [2].

Dynamic contrast enhanced magnetic resonance imaging (DCE-MRI), is an emerging imaging method used to assess tumor angiogenesis. It relies on fast MRI sequences obtained before, during and after the rapid intravenous administration of a gadolinium based contrast agent [3] so that the variations of MR signal intensity with time can be recorded for each image voxel. As the agent enters into a tissue, it changes the MR signal intensity from the tissue to a degree that depends on its local concentration [4].

Dynamic contrast enhanced MRI (DCE-MRI) has been investigated for the differentiation of tumor recurrence and post-treatment fibrosis in regions, other than head and neck, such as the breast, pelvis, gastrointestinal and musculoskeletal system [5,6]. In the head and neck region, DCE-MRI is an adjuvant clinical tool used in the evaluation of soft tissue neoplasms and lymph nodes, and is thought to be a useful predictor of response to radiotherapy. It is also used to monitor the treatment and distinguish post-therapeutic changes from recurrent mass with greater confidence [7–10].

The aim of this study was to investigate the role of dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) in the differentiation between recurrent salivary gland tumors and post-treatment changes.

2. Patients and methods

2.1. Patients

Dynamic contrast enhanced imaging (DCE-MRI) and conventional post-contrast MRI of salivary glands were performed prospectively in 37 consecutive patients (22 males and 15 females) with treated malignant salivary gland tumors between January 2014 and July 2015. Their age ranged 38–79 years. All patients were referred to our department from the follow-up clinics of the radiation therapy and oncology departments of Mansoura University Hospitals. Patients were evaluated because of recurrence of symptoms ($n = 20$) or abnormal physical examination findings during routine follow-up ($n = 17$). Three patients were excluded from the study due to bad MR images caused by motion artifact in two patients and because of claustrophobia in one patient. We obtained the approval of the institutional review board of our hospital and an informed consent from the patients before the study.

Our MR diagnoses were correlated with histopathological findings in twenty-six patients ($n = 26$) or with, clinical follow-up in 8 patients ($n = 8$). Histopathological diagnoses were done by surgical biopsy in thirteen patients ($n = 13$), core biopsy in seven patients ($n = 7$), and fine needle aspiration biopsy in six patients ($n = 6$). The selection of the site of biopsy was guided by the imaging findings on conventional

and DCE-MR. The surgeons selected the biopsy site after discussing the MR findings with the radiologists. When there was suspicion of more than one pathological condition, multiple biopsies were taken from the suspicious sites. The time delay between the biopsy and MR studies varied between 7 and 15 days.

Clinical follow-up for one year was considered as post-treatment changes if there is no change or decrease in the size of the lesion under question and no new lesions appeared and are considered as a tumor recurrence if the lesion increased in size or new lesions appeared.

2.2. MRI protocol & image interpretation

MR images were obtained with a superconducting 1.5 T MR imaging unit (Philips Ingenia) using neck array coil for all cases. Precontrast reference scan was first performed through the region of interest (ROI) and was followed by intravenous injection of gadolinium dimeglumine (Meglumine Gadopentetate, Magnevist). The standard MR acquisition parameters were as follows: Multiplanar (axial, coronal, and sagittal) T2-weighted images, axial T2 fat-suppressed fast spin-echo images (TR, 5000 ms; TE, 102 ms; averages, 2; matrix, 256×256; section thickness, 4.0 mm; and gap, 1.0 mm) and axial T1-weighted images (TR, 675 ms; TE, 20 ms; averages, 2; section thickness, 4.0 mm; gap, 1.0 mm; matrix, 256×192). Conventional T1- and T2-weighted images were followed by DCE-MRI. Then, post-contrast axial, sagittal and coronal T1-weighted images were finally obtained.

Characterization of the lesions on the conventional MRI was based upon morphological criteria regarding tumor volume, signal intensity (SI) in different sequences and enhancement after Gd-DTPA. Areas with very high SI (equivalent to water) on T2-weighted images were interpreted as necrosis or cystic degeneration and the very low SI areas on T1- and T2-weighted images were interpreted as fibrosis. Lesions with iso to hypointense areas on T1 and T2WI that showed enhancement after contrast injection and positive mass effect to its surroundings, were regarded as recurrent tumors.

2.3. DCE-MRI protocol

Using automatic injector, a single bolus dose of gadolinium dimeglumine was injected intravenously, at a dose of 0.3 ml/kg body weight and at an injection rate of 2.5 ml/s, followed by a 20 ml saline flush.

A dynamic two dimensional, spoiled gradient recalled echo (2D-SPGR) axial T1WI fat suppressed sequence was done with total acquisition time of 240 s during bolus injection of the contrast agent. The imaging parameters are as follows: 10.4 ms repetition time (TR), 2.3 ms echo time (TE), 30° flip angle; 4 mm section thickness, section gap 1 mm, 180–240 mm field of view (FOV), and 256×128 mm matrix size.

2.4. Image post-processing

The sequential dynamic MR images were transferred into Philips extended work space (EWS) 2.6 workstation using its specific software. The ROI was manually placed in the solid most enhancing portion of the lesion avoiding the necrotic areas.