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The role of magnetic resonance imaging in early detection of recurrent breast cancer

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ABSTRACT

Purpose: The purpose of this work was the evaluation of new advances of magnetic resonance imaging (MRI) in diagnosis of recurrent breast cancer after conservative surgery, chemotherapy and radiotherapy.
Introduction: Breast conservation surgery followed by breast radiotherapy and chemotherapy produces changes on both physical examination and on post-treatment breast imaging. Distinguishing these normal treatment-related findings from breast cancer recurrence in the original lumpectomy site or elsewhere in the breast (new primary tumors) is challenging.
Introduction: Our prospective study is done on fifty female patients who had undergone breast-conserving therapy at least 6 months since the end of radiation therapy. All cases were suspected for either recurrence or post-operative complications by clinical examination in conjunction with mammography and/or US. Confirmation of different lesions was achieved by fine needle aspiration biopsy, core or excisional biopsy. All patients were examined by dynamic contrast enhanced MRI (DCE-MRI). If one of imaging modalities suspected recurrence, all of the imaging modalities were performed.
From our study we concluded that MRI is useful examination that can provide very valuable information in patient with suspected recurrence. It is a technique that offers not only information on lesion cross sectional morphology but also on functional lesion features such as tissue perfusion and enhancement kinetics.

1. Introduction

A close follow up of patients after breast conserving therapy (BCT) is necessary because tumor recurrence ranges between 1% and 2% per year. It typically occurs 3–7 years after BCT. Early detection of local recurrence of breast cancer has been shown to significantly improve long-term survival [1].

Breast conservation surgery followed by breast radiotherapy produces changes on both physical examination and post-treatment breast imaging. Detection of local tumor recurrence, as well as evaluation of the remainder of the breast tissue by conventional methods can be difficult due to post treatment alteration, especially within dense breasts; hence, repeated biopsy is often required [2].

The breast conservative surgery including lumpectomy, partial mastectomy, and segmentectomy is aiming at surgical excision of the breast cancer with a surrounding margin of histologically normal breast parenchyma while conserving the patient's breast appearance and form. Breast conservative surgery is the most common surgical option for patients with early stages of breast cancer, typically T1 or T2 [3].

Chemotherapy leads to necrosis and fibrosis, which appear as persistent density on mammogram. Similarly, calcifications associated with a carcinoma can persist even when the viable tumor cells are no longer present. Both persistent density and calcification can be incorrectly identified as carcinoma on mammogram, resulting in false positive results [4], Moreover mammographic evaluation within the 1st 12 months after radiation is frequently impaired by radiation induced changes.

Ultrasound (US) may be of limited ability in detection of neoplastic recurrence, as it is operator dependent, and the hypoechogenicity with posterior acoustic shadowing at the site of scarring tissue can limit the proper evaluation due to their similarity to patterns seen with recurrent tumors. There is also diminished reliability of US for detection of small and non-invasive cancers, even in the untreated breasts. Extensive scarring after multiple operations or complicated healing can cause diagnostic

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problems making the exclusion or the demonstration of neoplastic recurrence too difficult [5].

DCE-MRI has been shown to aid significantly in detection and characterization of primary and recurrent breast cancers. The sensitivity of breast MR imaging for detection of residual and recurrent tumors in the post-operative breast is over 90%. Breast MR imaging has been shown to be useful in differentiating scar tissue from tumor recurrence regarding the non-enhancing areas which have a high negative predictive value for malignancy (88–96%) [1].

It is also a valuable technique and more specific in differentiation of post irradiation changes from recurrent carcinoma in patients who had undergone breast irradiation [4].

DCE-MRI together with MR spectroscopy is known to enable the most accurate assessment of tumor response in breast cancer after neoadjuvant chemotherapy (NAC) in comparison with other conventional techniques. It is able to monitor complete, partial and poor response [6].

2. Patients and methods

Fifty female patients were subjected to this prospective study, their ages ranged from 27 to 67 years with mean of 47 years, the study was done at Alazhar University Hospitals in the period between June 2014 and October 2015, the patients were referred to the Radio-diagnosis Department from the general and oncology surgery units. Also outpatients were included. All cases had undergone BCT with at least 6 months spare period since the end of irradiation therapy. All cases were suspected for either recurrence or post-operative complications by the clinical examination in conjunction with mammography and US. Confirmation of different lesions was achieved by fine needle aspiration cytology, core or excisional biopsy.

All patients were instructed to come whenever possible during the 1st half of the cycle to avoid the associated prominent enhancement of the breast parenchyma due to the physiological hormonal effect that may obscure or mimic the malignancy.

All patients had undergone one of the different approaches of BCT with or without post-operative irradiation and chemotherapy.

Forty-one patients were submitted to post-operative radiation and chemotherapy; the remaining 9 patients were submitted to surgery alone.

An irradiation therapy and NAC were mainly given after surgery in cases with +ve axillary lymph nodes, large 1ry tumor (>2 cm), 1ry cancer of high grade (III) or if cancer cells were negative for hormone receptors.

Inclusion criteria at MRI examination consisted of history of BCT with suspicion of neoplastic recurrence either clinically or in mammography and ultrasound. Exclusion criteria were the recent irradiation therapy (up to 6 months after termination of therapy) and usual contraindications for performing MRI such as claustrophobia, marked obesity, metal devices in the body, and pacemaker.

All patients were examined by MRI ± Mammograms and Ultrasound. If one of the imaging modalities suspected neoplastic recurrence, in such cases all of the imaging modalities were performed.

Specific breast history was taken regarding the patient breast risk factors, family history, breast lumps, scars, or other areas of complaint. The patient details are regarding the location, date, and the results of previous breast biopsy. The patient also documented any use of exogenous hormonal therapy and the phase of the menstrual cycle or menopause.

2.1. Technique of mammography

The mammogram was mainly performed to grossly confirm or exclude the presence of a lesion and detect micro-calcifications. The machine used was Stephanix 800S.

The mammographic views were done including cranio-caudal and medio-lateral views and specific views such as magnified and localization views for more proper evaluation of a suspicious lesion were also done.

2.2. Technique of ultrasound examination

The ultrasound was performed for specification and evaluation of mammographically detected opacities and for exclusion of post operative collections, residual or recurrent lesions. All ultrasound examinations were performed on GE logiq S6 (using a high frequency linear 12 L transducer with frequency range 4.5–13 MHz) and Toshiba Xario SSA-660A (using a high frequency linear probe, PLT 805 AT transducer with frequency range 6.2–12 MHz).

2.3. Technique of magnetic resonance imaging

Before MRI scanning, the patient fulfilled an MRI safety form to exclude contraindications of entering the strong magnetic field, such as ferromagnetic vascular clips, metallic ocular fragments, pacemakers, and implanted electromechanical devices. A qualified person reviewed the standardized MRI safety forms before scanning.

The qualified nurse placed MRI-compatible markers on the patient's breast to indicate lumps location or areas of concern and annotated them on the history form; All MRI studies were performed on a superconducting magnet system (1.5 T. Philips Achieva, class II a, USA). All patients were placed in prone position using a dedicated double phased array breast coil. The majority of patients were comfortable for the duration of the entire scan with both arms at their sides. The patients were instructed to "hold still" during the scan time in order to obtain the best imaging quality. IV catheter, was placed before scanning and continuously flushed by normal saline solution.

The imaging protocol consisted of bilateral simultaneous axial and coronal images of both breast, as well as sagittal images of the diseased side.

An axial T1-weighted localizer sequence through both breasts was initially taken, and precontrast T1W frames with and without fat saturation were acquired in the axial plane (TSE; parallel imaging; flip angle = 90; TR = 9.9 ms; TE = 4.2 ms; NEX, 1; 2–4 mm slice thickness with no gap; matrix 512 × 192, FVO = 35) and also T2WI (TSE; parallel imaging with TE 80–120 ms and TR at least 3000 ms. 2–4 mm slice thickness with no gap; matrix 512 × 192, FVO = 35). For post contrast and dynamic series, intravenous injection of 0.1 mmol per/kg of gadopentetate dimeglumine (Gd-DTPA, Magnevist) was done at flow rate 2 ml/s, followed by 20 ml flush (normal saline) at the start of the acquisition. Imaging time with this frame was approximately 80 s. Axial T1 WIs with fat suppression and subtracted images acquisition were done after the DCE-series. For kinetic analysis and acquisition of time-signal intensity curve, Axial fast 2D GRE acquisition was planned. Five 2D image sets with fat suppression were performed within the first 7 min following intravenous administration of contrast agent. A small region of interest (ROI < 3 pixels) was placed selectively over the most intensely enhancing area of the lesion. Signal intensity/Time curves were constructed. Diffusion-weighted imaging (DWI) was performed before the DCE-MRI acquisition in an axial plane using a 2D spin echo-echo planar imaging (SE-EPI) sequence with a parallel acquisition technique using the signal intensity and two different B-values. To assess ADC value the region of interest (ROI) was manually drawn avoiding the necrotic or cystic components by referring to DCE-MRI and T2-weighted images; The ADC value was calculated as the mean of the voxels within the ROI of the tumor. For 1H spectroscopy, used for assessment of choline peak,

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