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Original Article

Dual energy contrast enhanced soft tissue digital mammography versus ultrasound elastography in the evaluation of breast masses

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ABSTRACT

Purpose: To evaluate the value of dual energy contrast enhanced (DECE) soft tissue digital mammography and ultrasound elastography (UE) in the detection of breast lesions and discrimination between benign and malignant ones.

Patients and methods: 32 female patients with breast lesions were prospectively evaluated at the female imaging unit of Diagnostic and Interventional Radiology Department of the National Cancer Institute, Cairo University. Routine sono-mammography was done for each patient then these patients were submitted to DECE soft tissue digital mammography as well as UE.

The DECE digital mammography scans were held via GE Senographe 2000D "GE Healthcare; Chalfont St-Giles, UK" FFDM system with some specific software and hardware adaptations.

The UE exams were held on ultrasound scanner with elastography unit and 7.5 Mhz linear array electronic probe (Hitachi digital, EUB- 7500; Hitachi medical, Tokyo, Japan).

Results: This study showed that sensitivity and specificity of DECE soft tissue digital mammography and UE were 86.3%, 60% and 80.9%, 40% respectively.

Conclusion: DECE soft tissue digital mammography demonstrated significant increase in the sensitivity without a loss in specificity. DECE soft tissue digital mammography is fast-reproducible imaging tool without operator dependency. DECE soft tissue digital mammography and UE are valuable tools to evaluate equivocal lesions.

1. Introduction

The most common female neoplasm is breast cancer which is ranked as the second-leading cause of death among women. Breast masses were first categorized as benign or malignant [1].

Breast imaging has undergone a major change, once the full-field digital mammography (FFDM) equipment has been introduced. These equipments might be proved to have additive value for conventional mammography in some selected cases [2].

The mammography also lacks sensitivity as 10–20% of breast cancers, 9% of those already palpable, are not depicted. Because of superior contrast resolution, it has been hoped that FFDM will prove superior to conventional mammography studies in the detection of breast cancers [3]. Techniques had made use of the technical properties of FFDM to increase its capability to detect more occult breast cancers. One of the proposed ideas is to enhance detection of the mammographically occult breast cancers through using an intravenous iodinated contrast agent. Unfortunately, the digital subtraction angiography with fluoroscopic guidance of the breast proved to be clinically invaluable in the evaluation of the breast lesions after trials for years. Breast cancers are found to have the characters of enhancement after using iodinated contrast agents at CT and MRI [3].

The benign breast masses differ inherently from malignant ones regarding their firmness. The clinicians have used that fact during breast palpation. Thus, harder and less mobile breast lesions are sought to be malignant. Palpation is also known to be subjective and lacking sensitivity to small deeply seated breast lesions [4].

Therefore, improving palpation sensitivity and reducing its subjectivity could have a significant impact on breast cancer diagnosis [5].

The field of breast ultrasound also shows a momentous change by introduction of the concept of ultrasonographic strain imaging,

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known as ultrasound elastography "UE". This has been developed to measure the breast lesions stiffness relative to the stiffness of the surrounding tissue. The information displayed considered as a reflection for that obtained with manual palpation. Based on stiffness differences between the breast lesion and the surrounding tissue, UE might allow the discrimination between benign and malignant breast lesions [3].

The principle of elastography is based upon the strain "displacement within the tissue" produced by tissue compression. Therefore, we can estimate tissue stiffness that could be useful in the differentiation between breast lesions [6]. Elastography might allow radiologists to discriminate benign from malignant breast masses based upon its clinical use to examine patients presented with a variety of breast lesions. Thus, it could significantly reduce the number of unnecessary breast interventions such as biopsies or aggressive surgeries [7].

The current study aimed to evaluate the technique of dual-energy contrast-enhanced (DECE) digital soft tissue mammography in the detection of breast cancer and comparing its results to the results of another novel technique which is UE and to evaluate how these techniques could reduce the indications for the breast biopsy in the diagnosis of breast lesions, with special focus on: determination of the sensitivity and specificity of DECE soft tissue digital mammography as well as ultrasound elastography in the evaluation of breast masses. Secondly, assessment of the ability of DECE soft tissue digital mammography or ultrasound elastography to provide additional information for further characterization of equivocal findings by the routine sono-mammography, guiding the management plan towards the biopsy or follow-up.

2. Patients and methods

2.1. Patients

Thirty-two female patients presented with breast lesions at the female imaging unit of the Diagnostic and Interventional Radiology Department of the National Cancer Institute, Cairo University. Patients were referred from the outpatient clinics of the surgical and medical oncology departments. The mean age was 47.56 years (age range, 22–80 years).

The study was approved by the Ethics Committee of the National Cancer Institute. Comprehensive explanations of the procedures were done for all patients and then each patient signed an informed consent form. This study included patients who have positive ultrasonographic and/or mammographic findings of breast masses. While patients with breast implants, with superficial (<5 mm deep to the skin surface) and cutaneous lesions as well as with purely cystic lesions on conventional ultrasound examination were excluded.

2.2. The imaging procedures

The patients underwent routine mammography and breast ultrasound examinations. Then, the patients were submitted to DECE soft tissue digital mammography and the real-time UE.

2.2.1. Equipments

The DECE soft tissue digital mammography scans were held via GE Senographe 2000D "GE Healthcare; Chalfont St-Giles, UK" FFDM system with some specific software and hardware adaptations. This uses a current FFDM system with a flat panel detector and CsI absorber, del pitch of 100 mm, image matrix size 1.914 × 2.294 (Senographe DS), field size 19 × 23.

The UE exams were held on ultrasound scanner with real time tissue elastography unit and 7.5 Mhz linear array electronic probe (Hitachi digital, EUB- 7500; Hitachi medical, Tokyo, Japan).

2.2.2. Techniques

2.2.2.1. DECE soft tissue digital mammography.

- An intravenous "IV" cannula was inserted into the antecubital vein "preferably the arm contralateral to the breast of concern". A one-shot IV injection with a dose of 1.5 ml/KG body weighted at a rate of 3 ml/s of non-ionic contrast agent (Omnipaque 350, Guerbet France) was then performed. Two minutes later, the breast was compressed in a CC position and a pair of low and high-energy images were obtained. The breast was then compressed in the MLO position and a new pair of low- and high-energy exposures were performed about 4 min after the contrast administration. Processing the low- and high-energy images to generate subtracted images is performed [11].

2.2.2.2. Ultrasound elastography. Breast lesions were evaluated first by; conventional B-mode ultrasound after spreading acoustic coupling gel on to the skin. Radial scanning of the entire breast and axillary tail of both sides was performed. Longitudinal and transverse images of breast lesions were obtained.

Images were classified into five categories according to the **BIRADS** system of the American College of Radiology Criteria for ultrasound:

- Category 1: normal findings.
- Category 2: benign findings.
- Category 3: probably benign findings.
- Category 4:
  - a: low risk of cancer.
  - b: intermediate risk of cancer.
  - c: high risk of cancer.
- Category 5: findings highly suggestive of malignancy.

2.2.2.2.1. Elastography examination. On the same session, real time free hand UE examination was performed. It was found that the suitable compression is maintained by keeping the "press indicator" below 3. We chose a color map in which red and green colors indicate softer areas, while blue color indicates harder areas. All lesions were studied using a split image, displaying a B-mode image on one side and T-Elasto mode on the other side. We set the ROI to include a sufficient area of normal gland surrounding the lesion.

In the qualitative (color coded) evaluation of the elastographic images, the lesions classified according to Tsukuba scoring system (a 5-point scoring method) proposed by Itoh et al. [6]. In the semi-quantitative evaluation of the elastographic images, the strain ratio of the lesions were calculated. The strain ratio was automatically obtained as the strain measured via normal-appearing breast region/the strain measured via the region of interest including the lesion ratio.

2.2.3. Imaging analysis and interpretation

- In mammographic studies, the lesions were evaluated regarding size, site, shape, margin, definition and density ± calcifications.
- In post contrast mammography studies, the lesions were evaluated regarding size and pattern of enhancement.
- B-mode ultrasound examinations of all lesions were evaluated regarding, shape, boundary, orientation, margin, echo pattern and posterior acoustic features ± calcifications. Surrounding tissue condition was also included in the final assessment.

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