G Model
EURR-5617; No. of Pages 5

ARTICLE IN PRESS

European Journal of Radiology xxx (2011) xxx–xxx

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Evaluation of tomosynthesis elastography in a breast-mimicking phantom

Florian Jan Engelken*, Ingolf Sack[1], Dieter Klatt[2], Thomas Fischer[3], Eva Maria Fallenberg[4], Ulrich Bick[5], Felix Diekmann[6]

Department of Radiology, Charité Universitätsmedizin Berlin, Chariteplatz 1, 10117 Berlin, Germany

ARTICLE INFO

Article history:
Received 15 March 2011
Accepted 7 June 2011

Keywords:
Breast
Tomosynthesis
Elastography
Phantom study

ABSTRACT

Objective: To evaluate whether measurement of strain under static compression in tomosynthesis of a breast-mimicking phantom can be used to distinguish tumor-simulating lesions of different elasticities and to compare the results to values predicted by rheometric analysis as well as results of ultrasound elastography.

Materials and methods: We prepared three soft breast-mimicking phantoms containing simulated tumors of different elasticities. The phantoms were imaged using a wide angle tomosynthesis system with increasing compression settings ranging from 0 N to 105 N in steps of 15 N. Strain of the inclusions was measured in two planes using a commercially available mammography workstation. The elasticity of the phantom matrix and inclusion material was determined by rheometric analysis. Ultrasound elastography of the inclusions was performed using two different ultrasound elastography algorithms.

Results: Strain at maximal compression was 24.4%/24.5% in plane 1/plane 2, respectively, for the soft inclusion, 19.6%/16.9% for the intermediate inclusion, and 6.0%/10.2% for the firm inclusion. The strain ratios predicted by rheometrical testing were 0.41, 0.83 and 1.26 for the soft, intermediate, and firm inclusions, respectively. The strain ratios obtained for the soft, intermediate, and firm inclusions were 0.72 ± 0.13, 1.02 ± 0.21 and 2.67 ± 1.70, respectively for tomosynthesis elastography, 0.91, 1.64 and 2.07, respectively, for ultrasound tissue strain imaging, and 0.97, 2.06 and 2.37, respectively, for ultrasound real-time elastography.

Conclusions: Differentiation of tumor-simulating inclusions by elasticity in a breast mimicking phantom may be possible by measuring strain in tomosynthesis. This method may be useful for assessing elasticity of breast lesions tomosynthesis of the breast.

1. Introduction

Tomosynthesis of the breast is a new imaging technique that reduces superimposition of breast lesions by overlying structures such as glandular tissue and allows more precise visualization of lesion borders [1]. This may lead to better detection and characterization of breast masses compared to digital mammography [2,3].

Assessment of the elasticity of breast lesions using ultrasound elastography has been shown to be helpful in differentiating benign from malignant breast lesions [4–6]. Other methods of assessing elasticity, such as MR-elastography are under investigation [7]. In sonographic elastography, the deformation of a target lesion in relation to the surrounding tissue under different amounts of physical compression is used for judging elasticity. Compression is also applied in radiographic techniques such as mammography and tomosynthesis of the breast; to the best of our knowledge, however, this has so far not been used to obtain elastographic data.

A variety of methods can be used for ultrasound elastography [8]. In this technique, results are often shown as strain maps, which display relative tissue displacement under compression. Strain can also be expressed as change in diameter in one or more planes.

While in conventional mammography, lesion borders are often somewhat indistinct, improved depiction of lesion borders by tomosynthesis may increase the potential to accurately and reproducibly measure lesion diameter [9]. Mechanical strain imposed on the breast by variable deformation forces and captured by tomosynthesis can potentially provide information on the elasticity of lesions if lesion diameter is measured accurately (Fig. 1). A similar approach was used successfully in ultrasound elastography before more sophisticated techniques were available [10]. The aim

* Corresponding author. Tel.: +49 30 450 627 308; fax: +49 30 450 527 968.
E-mail addresses: florian.engelken@charite.de (F.J. Engelken), ingolf.sack@charite.de (I. Sack), dieter.klatt@charite.de (D. Klatt), thom.fischer@charite.de (T. Fischer), eva.fallenberg@charite.de (E.M. Fallenberg), ulrich.bick@charite.de (U. Bick), felix.diekmann@charite.de (F. Diekmann).
[1] Tel.: +49 30 450 539 058; fax: +49 30 450 539 901.
[2] Tel.: +49 30 450 539 118; fax: +49 30 450 539 901.
[3] Tel.: +49 30 450 627 238; fax: +49 30 450 527 968.
[4] Tel.: +49 30 450 627 105; fax: +49 30 450 527 968.
[5] Tel.: +49 30 450 627 001; fax: +49 30 450 527 968.
[6] Tel.: +49 30 450 627 627; fax: +49 30 450 527 968.

0720-048X/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ejrad.2011.06.033