Role of Ultrasound Elastography in the Differentiation of Breast Lesions

Owvass Hamied Dar, Pankaj Sharma, Shaheen Hassan Dar, Maqsood Ahmad Dar[1]

Department of Radiodiagnosis, Delhi State Cancer Institute, Delhi, [1]Department of Medicine, Government Medical College, Srinagar, Jammu and Kashmir, India

Correspondence: Dr. Owvass Hamied Dar, BulBul Nowgam Anantnag - 192 201, Jammu and Kashmir, India. E-mail: darowais@yahoo.com

ABSTRACT

Background: Breast biopsy remains the gold standard for diagnosis of breast lesions; however, most of the breast specimens reveal benign results. Therefore, in order to avoid unnecessary breast biopsies, noninvasive diagnostic tools have been developed. Ultrasound elastography (USE) is a noninvasive technique which helps in reducing the frequency of breast biopsies. **Aims:** The aim of the study was to study the role of ultrasound elastography in differentiation of breast lesions which will ultimately help in better patient diagnosis. **Materials and Methods:** In this study, 54 patients with 66 breast lesions were first assessed with sonography and then with USE after obtaining informed patient consent. The examination was carried out in Department of Onco Imaging, Delhi State Cancer Institute, Delhi, India. from July 2011 to February 2012. **Statistical Analysis:** Statistical analysis was performed using SPSS software (version 20.0). **Results and Conclusion:** The lesions were classified on elastography using scoring system described by Itoh *et al*., 2006 with elasticity score of 1,2,3 as benign and score of 4 and 5 as malignant. The sensitivity of USE was found to be 88.57% with specificity of 90.32% and positive predictive value of 91.18%. Thus, we conclude that in the present scenario, USE can be used in early diagnosis and differentiation of breast masses into benign and malagnant and henceforth, can be influential in reducing the number of breast biopsies.

Key words: Benign and malignant breast lesions; B-mode sonography; histopathology; Itoh elasticity score; ultrasound elastography

Introduction

The rising incidence of breast cancer has led to tremendous research and innovations with consequent development of new diagnostic techniques.[1,2] The recent development of breast ultrasound elastography (USE) has produced promising results in early diagnosis and differentiation of breast lesions. The elasticity of soft tissues depends on their molecular building blocks (fat, collagen, and other biochemical molecules) as well as on microscopic and macroscopic structural organization of these blocks.[3]

USE differentiates between benign and malignant lesions on the basis of elasticity of tissues[4] with benign lesions having elasticity similar to adjoining normal tissues, while malignant lesions (being harder clinically) have lower elasticity as compared to adjoining normal tissues.[5] In comparison, malignant tissues which have lower elasticity, display larger diameter in USE as compared to the B-mode sonography due to local infiltration and desmoplastic reaction.[6,7] The purpose of this study was to evaluate the role of USE in the early diagnosis and differentiation of breast masses. Benign tissues appear similar to surrounding tissues and display smaller diameter on elastography.[8]

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Materials and Methods

Patients

In this study, 54 patients with 66 breast lesions were first assessed with sonography and then with USE after obtaining informed patient consent. The examination was carried out in Department of Onco Imaging, Delhi State Cancer Institute, Delhi, India. Patients mean age was 40 years, ranging from 17 years to 61 years. Sonoelastography was done in newly screened patients with breast lesions, before any biopsy and/or other interventional procedure.

Study design

In each patient, bilateral whole breast sonography was

done in radial and antiradial planes using *Siemens Acuson Antares 5.0* scanner equipped with 7.5-13 MHz linear array transducer. USE was simultaneously performed with the attached sonoelastography unit so that stiffness of lesion could be measured using color mapping. The B-mode images were displayed alongside the elastography strain images to ensure that the elastography was done in the region of interest (ROI). We included the ROI, subcutaneous tissues, pectoralis muscles along with surrounding tissues in the scanning field. The patients were examined in supine position with arms behind the head. The ultrasound probe was lubricated with coupling gel on the skin surface. The probe was held lightly and perpendicular to the ROI during elastography.

Image interpretation

The elastography images were classified using the scoring system described by Itoh *et al*., which is as under:

Score 1: Shows normal strain. The entire lesion presents with same color pattern as normal breast. The lesion is more green in color.

Score 2: Shows strain over most of the lesion so that hypoechoic lesion presents with mosaic color pattern of red and green.

Score 3: Shows strain at the periphery so that lesion appears green at the periphery and red at the center.

Score 4: Shows no strain over entire hypoechoic lesion, the whole lesion appears red in color.

Score 5: Shows no strain over entire lesion and the surrounding parenchyma so that both the lesion and surrounding area appear red in color.

On Siemens Sonoelastography unit, green indicates medium tissue stiffness, blue indicates soft tissues stiffness, and red indicates harder tissue. The lesions with elastography score of 1,2,3 were considered benign and lesions with score of 4 and 5 were considered malignant.

Results

All patients went for histopathological examination using Ultrasound (USG)-guided Fine needle aspiration cytology (FNAC) (n = 29) or excisional biopsy (n = 30) or stereotactic FNAC (n = 7). The average age of patient was 40 years. There were 46.97% benign and 53.03% malignant lesions. Among the benign lesions, most nodules were fibroadenoma and among malignant nodules, most lesions were infiltrative ductal carcinomas [Table 1].

Fibroadenoma showed similar elasticity as surrounding tissues, but showed similar or smaller size on elastographic images as compared to B-mode images [Figures 1 and 2]. Breast cyst showed typical three-layered color pattern of blue, green, and red with red being the superficial color and blue being the deep one [Figure 3]. Fibrocystic changes showed similar elasticity as compared to surrounding breast parenchyma [Figure 4]. Breast cancer showed maximum stiffness and appeared larger in size on elastography images as compared with gray scale images because of microscopic infiltration and desmoplastic reaction [Figures 5 and 6].

After USG-guided FNAC or excision biopsy or stereotactic FNAC, two lesions (3.03%) with elasticity score of 4 and one lesion (1.52%) with elasticity score of 5 were found to be benign, whereas three lesions (4.55%) with elasticity score of 3 and one lesion (1.52%) with elasticity score of 2 were found to be malignant [Figure 7].

By using elasticity score of 1 to 3 as benign and elasticity score of 4 and 5 as malignant, we obtained sensitivity of 88.57%, specificity of 90.32%, and positive predictive value of 91.18%. False-positive rate was found to be 4.54%. Among the false positive cases, two cases were found to be lobulated fibroadenoma and one case was found to be breast abscess [Table 2].

Discussion

Breast cancer is one of the leading causes of malignancy worldwide and this has fuelled tremendous enthusiasm and research for early diagnosis of breast cancers. Early detection of cancer can reduce the morbidity and mortality arising out of breast malignancy.[9] USE was developed to help in the early detection and better differentiation of breast lesions.

The interpretation of breast lesions on B-mode USG relies mainly on morphological characteristics, whereas with the use of USE, differentiation of benign and malignant lesions was drastically increased due to variability in their firmness or elasticity. B-mode sonography mainly depends on shape, orientation, margin, internal echotexture, and presence of calcification. USG elastography additionally helps in determing the mechanical properties of tissues. The strain

Table 1: Number of lesions and pathological diagnosis

Benign	Pathological diagnosis	Number of lesions	Percentage
01	Fibroadenoma	23	34.85
02	Invasive ductal carcinoma	32	48.48
03	Breast abscess	01	1.51
04	Fibrocystic myopathy	04	6.06
05	Ductal carcinoma *in situ*	03	4.55
06	Breast cyst	02	3.03
07	Ductal ectasia	01	1.51
	Total lesions	66	100

Table 2: Elasticity score of benign and malignant lesions

Diagnosis	Elasticity score				
	01	02	03	04	05
Benign	07	14	08	02	01
Malignant	0	01	03	12	18

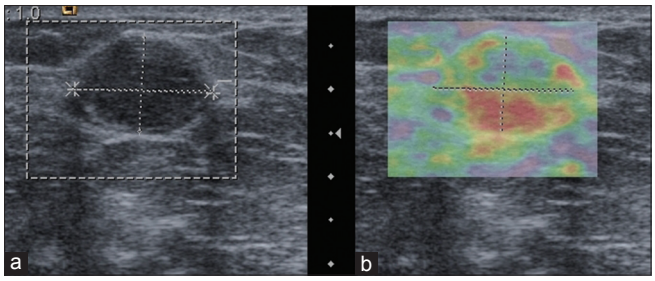

Figure 1: A 32-year-old woman with fibroadenoma. B-mode USG image (a) and USE image (b) shows well-defined circumscribed hypoechoic lesion that shows mosaic color pattern with Itoh elasticity score of 2

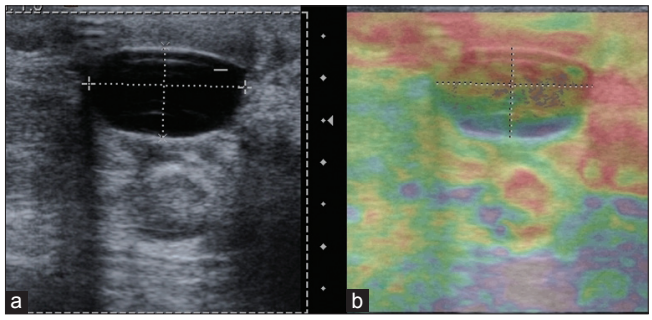

Figure 3: A 39-year-old woman with breast cyst. B-mode USG image (a) and USE image (b) shows well-defined anechoic lesion with three-layered color pattern on elastographic image typical of a cyst

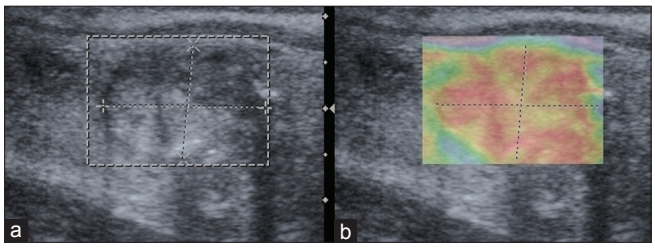

Figure 5: A 60-year-old woman with invasive ductal carcinoma. B-mode USG image (a) shows well-defined iso-hypoechoic lesion suggestive of benign lesion but appears red on USE image (b) with Itoh elasticity score of 4

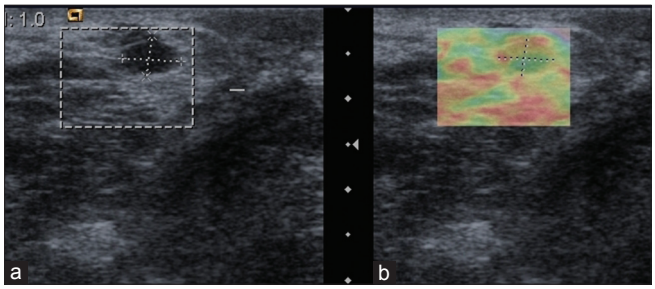

Figure 7: A 38-year-old woman with well defined hypoechoic lesion on B-mode USG image (a) and mosaic color pattern on USE image (b) with elastography score of 2, suggestive of benign lesion but pathological diagnosis was invasive ductal carcinoma (false-negative case)

and stiffness can noninvasively be determined by using USE and can be color-mapped with red color indicating region with low elasticity (harder tissue areas) and blue color indicating the region with higher elasticity (softer tissues).

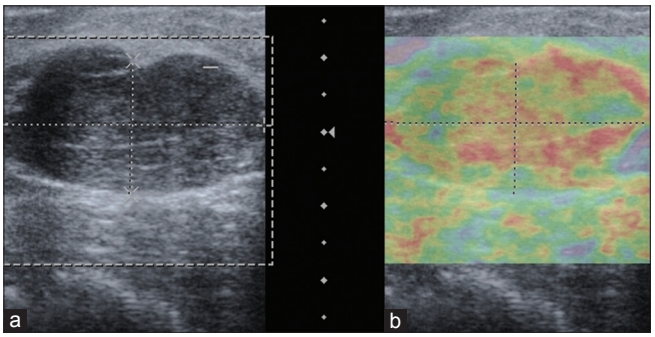

Figure 2: A 45-year-old woman with fibroadenoma. B-mode USG image (a) and USE image (b) shows lobulated well-defined hypoechoic lesion with strain at the periphery with Itoh elasticity score of 3

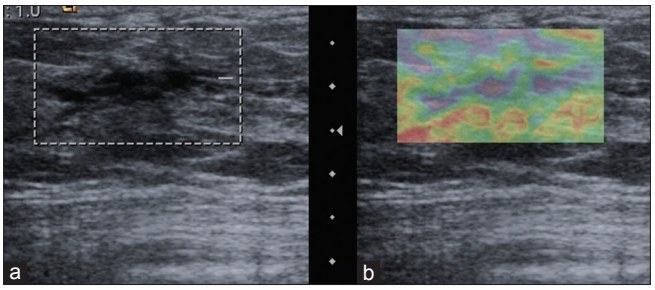

Figure 4: A 27-year-old woman with fibrocystic myopathy. B-mode USG image (a) shows hypoechoic fibrocystic changes and USE image (b) shows normal color pattern with Itoh elasticity score of 1 suggestive of benign lesion

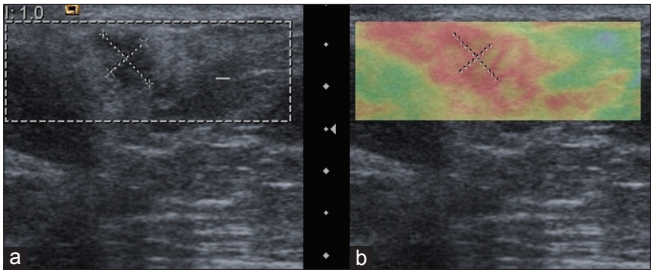

Figure 6: A 44-year-old woman with invasive ductal carcinoma. B-mode USG image (a) shows small irregular suspicious hypoechoic lesion. The lesion appears larger in size and red in color on USE image (b) because of local infiltration and desmoplastic reaction

Walz *et al*.,[10] in 1993 concluded that the elasticity characteristics in cancers, Fibroadenoma and normal breast parenchyma were different. Sarvazyan *et al*.,[4] in 1995 observed that neoplastic tissues were significantly harder than fibroadenoma and normal tissues. To use this property of elasticity of tissues, ultrasound equipped with elastography unit was developed in 2003-2004 for routine USE imaging.[11] For characterization of breast lesions, two elasticity scoring systems are widely used: The Tsukuba score developed by Itoh *et al*.,[5] and other by Italian Research Group after Locatelli, Rizzatto.[12] In our study, we obtained sensitivity of 88.57% and specificity of 90.32% which is consistent with other published studies on the use of USE by Garra *et al*., in 1997;[8] Itoh *et al*., in 2003[5]; Wang *et al*., in 2005[13]; Yu *et al*., in 2005,[14] and Thomas *et al*., in 2006.[15]

The use of elastography has drastically increased the differentiation of benign and malignant breast lesions, but its use is limited in very dense breast parenchyma and in case of hamartoma or breast implants.[16] USE has now also been used for differentiation of benign and malignant lesions in prostate, thyroid, lymph nodes, and liver lesions. As with B-mode imaging, there may be interobserver variability in interpretation of elastography images and to decrease that, adequate training and practice is required to learn the appropriate technique.

In conclusion, breast elastography is a simple, noninvasive diagnostic tool that provides additional information about stiffness of a mass and increases the sensitivity and specificity of USG especially when dealing with BI-RADS 3 or 4 category lesions. Combined use of B-mode imaging with USE increases enhanced differentiation of benign and malignant lesions with higher specificity and accuracy and can decrease the use of unnecessary breast biopsies, thereby decreasing the morbidity and mortality arising out of breast malignancies.

References

1. Ophir J, Cespedes I, Ponnekanti H, Yazdi Y, Li X. Elastography: A quantitative method for imaging the elasticity of biological tissues. Ultrason Imaging 1991;13:111-34.
2. Krouskop TA, Wheeler TM, Kallel F, Garra BS, Hall T. Elastic moduli of breast and prostate tissues under compression. Ultrason Imaging 1998;20:260-74.
3. Fung YC. Biomechanics: Mechanical properties of living tissues. Chapter 7, 2nd ed. New York City: Springer1993;242-314. Sarvazyan AP, Skovoroda AR, Emelianov SY, Fowlers JB, Pipe JG, Adlers RS, *et al*. Biophysical bases of elasticity imaging. Acoustical Imaging 1995;21:223-240.
4. Itoh A, Ueno E, Tohno E, Kamma H, Takahashi H, Shiina T, *et al*. Breast disease: Clinical application of US elastography for diagnosis. Radiology 2006;239:341-50.
5. Regner DM, Hesley GK, Hangiandreou NJ, Morton MJ, Norland MR, Meixner DD, *et al*. Breast lesions: Evaluation with US strain imaging-clinical experience of multiple observers. Radiology 2006;238:425-37.
6. Burnside ES, Hall TJ, Sommer AM, Hesley GK, Sisney GA, Svensson WE, *et al*. Differentiating benign from malignant solid breast masses with US strain imaging. Radiology 2007;245:401-10.
7. Garra BS, Cespedes EI, Ophir J, Spratt SR, Zuurbier RA, Magnant CM, *et al*. Elastography of breast lesions: Initial clinical results. Radiology 1997;202:79-86.
8. Tabar L, Yen MF, Vitak B, Chen HH, Smith RA, Duffy SW. Mammography service screening and mortality in breast cancer patients: 20-year follow up before and after introduction of screening. Lancet 2003;361:1405-10.
9. Walz M, Teubner J, Georgi M. Elasticity of benign and malignant breast lesion: Imaging, application and results in clinical and general practice. 8th International Congress on the Ultrasonic Examination of the breast; 1993.
10. Konofagou EE. Quo Vadis elasticity imaging? Ultrasonics 2004;42:331-6.
11. Rizzatto G. Real-time elastography of the breast in clinical practice-The Italian experience. Mediz Hitachi Suppl 2007;1:8-11.
12. Wang Y, Wang Y, Zhang XM, Qin QM, Wang YD, Xu ZZ. Evaluation of elastography application in differentiating benign and malignant breast tumours. Chin J Ultrasonogr (Chin) 2005;14:911-913.
13. Yu Q, Xu ZZ, Mao F. Preliminary application of elastography in diagnosis of breast diseases. Shanghai Med Imaging 2005;14:102-3.
14. Thomas A, Kümmel S, Fritzsche F, Warm M, Ebert B, Hamm B, *et al*. Real-time sonoelastography performed in addition to B-mode ultrasound and mammography: Improved differentiation of breast lesions? Acad Radiol 2006;13:1496-504.
15. Itoh A. Review of the techniques and diagnostic criteria of breast ultrasound elastography. Medix Hitachi Suppl 2007;1:8-11.
16. Lyshchik A, Higashi T, Asato R, Tanaka S, Ito J, Hiraoka M, *et al*. Cervical Lymph node metastasis: Diagnosis at sonoelastography-initial experience. Radiology 2007;243:258-67.

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