ORIGINAL ARTICLE

Sensitivity of Shearvawe Elastography in Differentiating Benign & Malignant Solid Breast Lesions

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[1,2] Conceived the topic and review the study & Discussion
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[6] Review the Study

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ABSTRACT

Objective: To determine the Sensitivity of Shear wave Elastography to differentiate Benign & Malignant solid breast mass lesions in correlation with Histopathology

Study Design: Cross sectional, Descriptive Study

Material & Methods: This study comprises of 105consecutive patients with palpable solid breast lesions, were subjected to Ultrasound shear wave elastography followed by Trucut biopsy for Histopathology. Two images of each lesion over the central and pericentral, stiff area were taken. minimum, mean & maximum values were calculated. Statistical analysis were carried out by using SPSS 20. ROC curve was developed. Sensitivity, specificity, PPV, NPV and cutoff values for benign and malignant lesion were calculated in relation to histopathology results

Results: A total of105 patients with solid breast lump were evaluated in this study. On histopathology out of 47 benign lesions 21 (44.6%) were found malignant while all 58 clinically and radiologically diagnosed cases were malignant on histopathology. Mean age of the patients with benign histopathology was 43.9±9.7 years while the mean age of patients with malignant histopathology was 43.7±9.2 years. The cut off mean elasticity value was 75kpa any lesion with value above 75 will be malignant while below will be benign. The area under ROC curve were 0.966 for mean 0.848 for minimum, & 0.975 for the maximum elasticity with Sensitivity of 95%, for mean,110.5% for maximum and 52%for minimum Specificity of87.2%, 86.17 %, 80.9% with a PPV of 89.15%, 75%, 89.83% and NPV of 89.13%, 87.87%, 95% for mean, minimum and maximum elastic values respectively.

Conclusion: SWE give rise to additional valuable quantitative data to gray scale ultrasound examination on solid breast lesions. It may serve as a complementary method for diagnosis of breast lesions. Although long-term clinical studies are required to accurately select lesions requiring biopsy.

Key Words: Benign, Cutoff, Histopathology, Malignant, Shear Wave Elastography, ROC, Ultrasonography

Introduction

Breast cancer is by far the most common cancer in females of both developed and developing countries, and remains a major public health problem[1].it is associated with high morbidity; ~1.38 million new cases and 458000 deaths occur annually worldwide.[1] Mammography is a valuable screening tool for early detection of breast cancers, particularly in fatty breast tissue. Its diagnostic accuracy decreases with increase in breast density which usually occurs in young females.[2, 3] Therefore other imaging methods / procedures are required. [4]

Gray-scale ultrasonography is a valuable adjunct to mammography and other breast imaging methods, affording highly sensitive assessment of breast masses and differentiating benign solid breast lesions from those

that are malignant.[5-7] However, ultrasonography is strongly subjective and specificity is very low.[8- 10]

Breast biopsy remains the gold standard for definitive diagnosis of suspicious breast lesions. Further, the pathological result is benign in up to 75% of all cases[11-13] A consistent, cost effective, reliable and non-invasive imaging method is needed to differentiate benign from malignant solid breast lesions would be valuable.

Shearwave Elastography is a new non-invasive imaging modality that uses ultrasound to assess tissue stiffness (elasticity), Two principal sono elastographic approaches are available; these are static (strain) and transient (vibration; shear wave) elastography Shear wave elastography (SWE) is a novel technique applicable to soft tissue. In shear wave elastography due to difference in stiffness of the solid breast lesions relative differences in tissue motion are produced and images at each location in the breast are calculated and displayed.[14,15] In SWE, transverse shear waves spreading laterally from the tissue are tracked, and the speed of propagation calculated. SWE yields real-time quantitative data and is highly reproducible compared to static elastography.[16, 17]

In this study stiffness values of series of breast solid lesions were recorded by using shear wave elastography. Mean values were studied in correlation with histopathological finding to differentiate benign from malignant breast lesions and also determine cut off elasticity values that allowing benign and malignant tumors to be distinguished.

Methodology

This prospective study was conducted on105 consecutive female patients with solid breast lumps visited to Breast clinic in Surgical Unit 4 of Civil Hospital Karachi from 1st January 2016 to 30th December 2016 in collaboration with Radiology Department of DMC / Civil Hospital Karachi. The age range was 30-60 years. All cystic lesions including abscesses were excluded from the study. After History, clinical examination was done and an informed consent for biopsy was taken. Patients above 35 years of age were subjected to mammography and below 35years only to Ultrasound. All patients were subjected to shear wave (SWE) ultrasound. Sonologist was kept blind about mammography findings. Shearwave ultrasound was performed on Aixplorer Supersonic Imagine ultrasound machine by an expert sonologist having at least 05 years' experience by using moveable unit displaying tissue stiffness on a color scale; progression from blue to red indicates increasing tissue stiffness. Two images of solid lesions were taken, one from the centre of lesion and another from periphery. Quantitive values of tissue stiffness were measured in kilopascals (kpa). Minimum, maximum and mean electrographic value of each solid lump was displayed on a databox with color scale from blue to red on a screen. Minimum value in our study recorded was 7kpa and maximum noted was 336kpa. After shear wave ultrasound (SWE) these patients had ultrasound guided trucut biopsy for breast lesion, which were sent for histopathology. Data was entered and analyzed on SPSS version 20. Quantitive evaluation of stiffness of mass, central and pericentral area, measured in terms of differences in minimum, maximum and mean elastography values of benign and malignant lesions. Student's t test was applied, p value was calculated. Receiver operator curve (ROC CURVE) was constructed for minimum, Maximum and Mean elastographic values. The values of these parameters maximizing the diagnostic accuracy were obtained. Sensitivity, Specificity, positive predictive value (PPV)and Negative predictive value(NPV)werealso calculated.

Results

This study were evaluated in solid breast lump in 105 consecutive patients, Mean age of the patients with benign histopathology was 43.9±9.7 years while the mean age of patients with malignant histopathology was 43.7±9.2years. (Table 1)

Table 1. Demographic and breast cancer screening characteristics of patients

	n	%
Age group (years)		
30 - 35	25	23.8
36 - 40	23	21.9
41 – 45	25	23.8
46 - 50	10	9.5
>50	22	21.0
shearwaveelastography (SWE)		
***Emax, kPa**	80.63±47.96	
***Emean, kPa**	109.43±57.50	
***Emin, kPa**	136.85±75.66	
BIRADS ® criteria		
BIRADS 2	14	13.3
BIRADS 3	12	11.4
BIRADS 4	37	35.2
BIRADS 5	42	40.0
Histopathology		
Benign	47	44.8
Malignant	58	55.2

BI-RADS¼Breast Imaging-Reporting and Data System
***Mean±SD**

Table 2. SWE Parameters Between Benign and Malignant Lesions on histopathology						
Shearwave elastography (SWE)	**Benign Lesions**		**Malignant Lesions**		**t-test**	**P-value**
	Mean	**SD**	**Mean**	**SD**		
***Emax, kPa**	73.3191	41.11072	188.3379	55.27926	11.85	<0.001
***Emean, kPa**	60.8255	38.33808	148.8241	36.32252	12.04	<0.001
***Emin, kPa**	48.3319	38.29602	106.8069	38.16011	7.79	<0.001

Out of which 47(44.8%) were benign and 58(55.2%) were malignant on Clinical and Radiological exanimation. On histopathology out of 47 benign lesions 21(44.6%) were found malignant (table III). The minimum, mean and maximum elasticity values of benign lesions were 48.33kpa, 60.82 kpa and 73.31 kpa respectively while for malignant lesions the elasticity values were higher than benign lesions (Table II).

Through graph the cut off mean elasticity value was 75 kpa any lesion with value above 75 will be malignant while below will be benign. The area under ROC curve were 0.966 for mean 0.848 for minimum, & 0.975 for the maximum elasticity (Figure 1) & (Table IV) with Sensitivity of 95%, for mean,110.5% for maximum and 52% for minimum Specificity of 87.2%, 86.17 %, 80.9% with a PPV of 89.15%, 75%, 89.83% and NPV of 89.13%, 87.87%, 95% for mean ,minimum and maximum elastic values respectively(Table V).

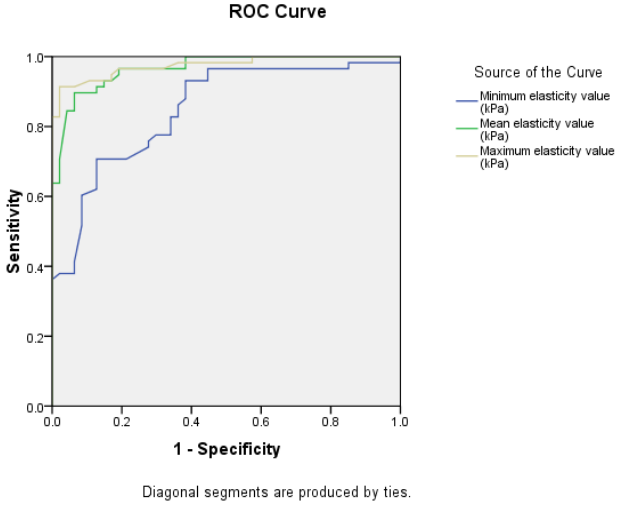

Figure 1. The receiver-operating characteristics (ROC) curves of Emax, Emean, and Eratio shearwave elastography (SWE) measurements in detecting malignant breast lesions

Table 3. Breast Lesions According to BI-RADS Classification Between Benign and Malignant Lesions on histopathology				
Breast Lesions According to BI-RADS Classification	**Histopathology characterization of Breast Lesions**			
	Benign Lesions		**Malignant Lesions**	
	n	%	n	%
Benign	26	100.0%	0	.0%
Malignant	21	26.6%	58	73.4%
Chi-square test value =42.645, P-value = <0.001				

Table 5. Sensitivity, Specificity, PPV, and NPV of SWE to Detect Malignant Breast Lesions					
Shearwave elastography (SWE)	**Cutoff Value**	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**
***Emax, kPa**	110.5	96.6	80.9	86.15	95
***Emean, kPa**	109.5	91.4	87.2	89.83	89.13
***Emin, kPa**	52.5	93.1	61.7	75	87.87

Table 4. Minimum elasticity value (kPa), Mean elasticity value (kPa), Maximum elasticity value (kPa) has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.					
Test Result Variable(s)	**Area under the curve**	**Standard Error[a]**	**Asymptotic p-value [b]**	**Asymptotic 95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Minimum elasticity value (kPa)	.848	.038	<0.001	.774	.922
Mean elasticity value (kPa)	.966	.015	<0.001	.938	.995
Maximum elasticity value (kPa)	.975	.013	<0.001	.949	1.001
a. Under the nonparametric assumption b. Null hypothesis: true area = 0.5					

Discussion

For the diagnosis of suspicious breast lesion biopsy remains the gold standard but the major proportion of it

turn to be a benign. Therefore, a non invasive procedure to identifying the low risk lesion is being studied using different ultrasonographic modalities including color Doppler, resistive index R.I and shearwaveElastography.[18] Evans et al[19] suggested elastographic standard deviation was a useful measure of hetrogeniety differentiating benign from malignant lesions, because the value was significantly higher in patients with malignant histopathology. While Deniz et al[20]suggested that standard deviation SD does not reflect the hetrogeniety of entire lesion because in shear wave elastography the values are obtained from a fixed ROI. Generally, from stiffest peritumoral area. This study focused on Sensitivity of shearwave elastography as anon invasive diagnostic tool for differentiating benign from malignant breast lesions. The sensitivity of a test is defined as the proportion of people with disease who will have test positive, this means sensitivity tells us how good the test is in identifying people with disease. The specificity of a test is the proportion of people without the disease who will have test negative. The mean elastic cutoff value in this study yielding the maximum sum of sensitivity and specificity was 75kpa, chang et al,[21] Evans et al[22] , Deniz et al[20], calculated mean elastic cutoff values of 80kpa, 50kpa and 45kpa respectively. In our study, the mean elastic cutoff value was associated with a sensitivity of 95%, Specificity of 87.2%, PPV value of 89.15% and Negative predictive value of 89.13% respectively. The histopathological grades of invasive tumors were significantly associated with higher shearwave elastographic values in this study, a higher histological grade associated with a higher mean stiffness is reported instudies.[23,24] The reason for higher Electrographic values of high grade tumors is stronger desmoplastic reaction exerted by peritumoral tissues. [25]

Limitation of our studies:

It was a single center study with small numbers of patients & different pathological types of lesions were not represented.

Conclusion

SWE provides quantitative elasticity information i-e tissue stiffness that can help to differentiate benign from malignant lesion. Therefore, it can be used as anon invasive and reliable method of identifying Breast lesions though the biopsy remains the gold standard.

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