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Original Article

Predictive value of ultrasonography in the diagnosis of palpable breast lump

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Abstract

A lump is the first symptom in over 80 percent of all patients with cancer of the breast. Consequently, the finding of any lump in the breast is a highly significant sign and warrants a thorough investigation. The present study was undertaken to study the predictive value of ultrasonography in the diagnosis of palpable breast lumps. Fifty-two female patients with palpable breast lumps that were unilateral underwent ultrasonography of the breast. Thirty-six of these patients who had solitary, unilateral, solid lumps were followed up with FNAC/biopsy/mammography and the findings were compared. The mean age group was seen to be 41 years. The youngest patient was 17 years old and the oldest was 80 years. The validity of USG in the diagnosis of palpable breast lumps was calculated. A sensitivity value of 95%, specificity of 94.10%, positive and negative predictive values of 95.50% and 93.75% were noted and were comparable to other similar studies. The sensitivity, specificity, positive and negative predictive values were statistically significant (p=0.0000006) and were comparable to the values obtained by different studies conducted elsewhere. Among the multiple USG parameters, shape, margins, vascularity, surrounding tissue character, sound transmission through the lump were more significant in the diagnosis of benign vs. malignant lumps. Echogenicity and echotexture were of less significance.

Key words: Breast lump, Ultrasound, FNAC

Ultrasound has an established role in assessing breast abnormalities as an adjunct to mammography in older women and as a first line investigation in young women with mammographically dense breasts. Some malignant breast lesions are not visible on mammography but are detected by ultrasound. The use of ultrasound in addition to clinical examination and mammography may result in an increased rate of breast cancer detection. The false negative rate of mammography in the detection of breast cancer has been consistently reported to be approximately 10%, as determined by studies such as the Breast Cancer Detection demonstration Project[1]. These mammographically occult lesions are often detected at physical examination and often occur in women with mammographically dense breasts. Therefore, a negative mammographic report cannot exclude malignancy in women with a palpable mass; the lesion should be biopsied if clinically indicated. A large number of patients with palpable breast lesions are referred to diagnostic breast centres for mammography and sonography to guide the treatment of breast mass and to screen the rest of the breast. Although the primary role of sonography in this clinical setting has previously been to exclude a simple cyst, it is now used to characterize solid masses, and the additional information obtained could improve the ability of imaging to exclude malignancy in the setting of a palpable mass.

In general, the outcome of a sonographic evaluation of a palpable breast mass falls into one of three categories. First, if the lesion is a simple cyst, no further workup is required, although aspiration can be performed if desired by the physician or patient. Second, if the palpable lesion is a solid mass or a complex cyst, further intervention is often required, such as fine needle aspiration, needle core biopsy or excisional biopsy. However, discrete noncystic masses in this category are now also being evaluated with other treatment strategies on the basis of the imaging characteristics of the masses, as described in ground breaking work by Stavros et al[2]. Third, if findings from the sonography are negative (no discrete cystic or solid lesion are seen to correlate with the palpable mass) and the findings from the

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mammography are negative, then the treatment of the palpable abnormality is based on the findings on physical examination.

If the lesion is suspicious at physical examination (discrete mass, fixed lesion, or firm region of thickening), tissue sampling is warranted. If the lesion is benign at physical examination, suggesting prominent fibroglandular tissue, then many clinicians choose a close interval follow up.

The negative predictive value of sonography with mammography for palpable abnormalities has been reported in a small series of patients, ranging from 96.5% to 100%: however, these studies were limited because of the small number of patient populations[1, 3]. A recent larger study describes a negative predictive value of 100%[2] Knowledge of the negative predictive value of sonography and mammography for palpable lesions would be valuable to the clinician and radiologist to support the decision to biopsy versus follow up a palpable abnormality.

Breast sonography is the most important adjunct to mammography for patients with palpable breast masses and normal or equivocal mammographic findings. Most carcinomas smaller than 1cm in diameter can be identified and analysed with respect to sonographic features using modern high resolution, linear array, real-time transducers[2]. A further indication for breast sonography is the diagnostic workup of impalpable masses manifesting as indeterminate densities on mammography.

The characteristic sonographic findings of benign tumours include a round or oval, slightly hypoechoic lesion with smooth borders or a pseudocapsule, homogeneous internal echoes, no central posterior acoustic shadowing, and normal surrounding tissue[4, 5]. The typical features of malignancy include irregular shape, irregular contour, hypoechogenicity, a surrounding echogenic rim due to compression and distortion of the surrounding tissue, and posterior acoustic shadowing[2, 6, 16].

Shape: US features that most reliably characterize masses as benign are a round or oval shape, circumscribed margins, and a width-to–anteroposterior (AP) dimension ratio greater than 1.4[7]. Features that characterize masses as malignant included irregular shape, microlobulations, and width-to–AP dimension ratio of 1.4 or less. A few gently curving, circumscribed lobulations (macrolobulations) are considered as benign features, whereas many small lobulations of 1-2 mm (microlobulation) are considered a malignant characteristic in a recent study[2].

Contour is one of the most important sonographic tumour features[8] .A pseudocapsule is a strong predictor of a benign lesion. ***Echotexture***, commonly divided into homogeneous and heterogeneous echo pattern is often considered as a less specific sonographic feature. ***Echogenicity*** has often been of less importance for the differentiation of solid masses, partly because no standardized definition of the parameters exists. By far most tumours are hypoechoic when compared with the adjacent echogenic fibroglandular tissue[7, 9]. More useful information can be gained by comparing tumour echogenicity with that of the fatty tissue of the breast rather than with that of adjacent echogenic fibroglandular tissue surrounding the tumour nidus[2]. Extensive hypoechogenicity is a prominent feature of carcinoma. Density perception by the human eye has been considered unreliable in evaluating echogenicity of breast masses, and the difference between density values of carcinoma and fibroadenoma was also found to be insignificant using gain-assisted densitometric evaluation[6].

Sound through transmission and the acoustic characteristics of the posterior wall are sonographic features frequently discussed in the literature. Central posterior shadow is a feature suggesting malignancy. A brightly reflected zone corresponding to the posterior margin of the tumour may suggest the presence of a fibroadenoma rather than carcinoma when posterior shadowing is present[10].

Edge or lateral shadowing, considered to be a characteristic of benign tumour, has also been reported in some malignant tumours and was recorded in 10% of carcinomas in one series[11].

The surrounding tissue of the tumour nidus is classified as being normal or having an echogenic rim or showing distortion. It is a matter of definition whether the echogenic rim, which strongly predicts malignancy, should be classified as a feature of the contour. Similarly, whether distortion, which is almost always associated with invasive ductal carcinoma, should be classified as a secondary rather than a primary sonographic feature as done by some authors. The identification of the echogenic rim can be difficult if the tumour nidus is surrounded by hyperechoic glandular tissue. The diagnosis of cancer is strongly suggested when the margins of the lesion appear to merge with or 'invade' the surrounding tissue.

The addition of ***colour Doppler*** studies to see the flow within the lumps can be an additional pointer in the diagnosis of breast lumps. Studies have shown a significant difference in the amount of blood flow within malignant and benign solid breast lumps. Colour Doppler signals in a lesion otherwise thought to be benign should prompt a biopsy, while the absence of signals in an indeterminate lesion is reassuring[12].

Attention must be paid to combinations of sonographic features rather than any single characteristic. For daily clinical practice, this features analysis must not be too complicated and a dichotomization of descriptors would be a practicable solution. As for example, round vs. lobulated shape; pseudocapsulated vs. irregular contour; homogeneous vs. heterogeneous internal echoes; normal surrounding tissue vs. distorted echogenic rim; normal vs. increased vascularity; normal vs. increased AP/L ratio; central vs. lateral edge shadowing.

Inter-observer variations may be a serious problem in breast imaging, and it has been reported that radiologists differ substantially in their interpretation of mammograms[13]. Sonography as an adjunct to mammography should always be performed with full knowledge of the mammographic findings[7]. Agreement on breast sonographic diagnosis is reported to be lower than for mammographic diagnosis, but the highest agreement was found on combined mammographic-sonographic interpretation[14]. The confusion associated with the success of sonography for characterization of breast tumours is not only due to inter-observer variability but is also caused by a great variation in the diagnostic features that different workers describe as useful. Some authors are ignoring diagnostic features that others find useful[9]. Standardization of sonographic features analysis for daily clinical practice is necessary to reduce the inter-observer variability and to improve the potential of breast sonographic features analysis. Further research on this subject should be encouraged to confirm the role of sonography for differentiation between benign and malignant breast tumours.

Aims and objectives

1. To calculate the predictive value of breast ultrasound in the diagnosis of solid breast lumps in a sample population by comparing ultrasound findings with ultrasound guided FNAC findings or open surgical biopsy findings.
2. To find out the more useful and specific criteria among the various ultrasonographic criteria used to differentiate between benign and malignant breast lumps.

Materials and methods

Selection of subjects

Patients who attended the Surgical OPD and/or the mammography unit of the radiology department at the TU Teaching hospital with palpable breast lumps were included in this study. Consent was taken prior to conducting the investigations in all patients.

The patients who had ***palpable*** breast lumps, which were ***solid*** on USG, were included in the study. Patients with cystic, multiple or bilateral lumps were excluded. Patients with a history of surgery for malignant lesion in the same or opposite side were also excluded.

Patient Positioning and Breast Survey Techniques

The patient is placed supine with the ipsilateral arm comfortably elevated to help spread out the breast and allow better evaluation of the axillary region. If the breast is large or pendulous, slight rotation of the chest to the contralateral side permits optimal scanning of the evenly distributed breast tissue surrounding the centrally located nipple. An abundance of acoustic couplant gel and a light touch by the operator are needed. For a large glandular breast, however, more compression with the transducer may be required to obtain better penetration. To ensure a better orientation of a breast lesion and better communication with the surgeon, the breast is examined by a radial fashion surrounding the nipple. The location of a lesion is labelled according to the breast quadrants or according to the o'clock position and the distance from the nipple e.g., 12:00/2 cm. Evaluation of a focal lesion with dynamic study graded compression should be routinely done to demonstrate the tumour and assess its margin and compressibility. The antero-posterior AP and lateral L dimensions should be recorded for reference of AP/L ratio. The scanner should be optimally set to fit the condition of individual patient.

Instrumentation

Breast US examination was performed using a handheld 7.5-MHz linear array transducer. Targeted real-time US was performed to examine the area of concern. When a focal lesion is visualized, sonographic parameters, including lesion dimensions, echogenicity, shadowing, and margin characteristics and vascular flow pattern was recorded.

Method for USG guided FNAC

After the lump was located clinically and with USG, it was fixed in position with one hand. The skin over the lump was painted with antiseptic (Povidone Iodine solution) and a 20 ml syringe fitted with a 22-gauge needle was used to puncture the mass. Vacuum is applied to the syringe by pulling the plunger and the needle was moved back and forth a few times within the mass under USG guidance. Vacuum was released and the needle was removed. The specimen in the needle was spread on glass slides and a few slides immersed in fixative solution (95% methyl alcohol) immediately. These slides were then stained with Papanicolaou or Giemsa stain at the Department of Pathology TUTH and cytological reports obtained.

Results

The study included patients who underwent ultrasonography of the breast at the Department of Radiology TUTH for palpable breast lumps**.** Thirty-six patients who had palpable, solid, unilateral breast lumps were included in the study. Those with cystic lumps and/or bilateral lumps were excluded. Patients who underwent surgery for previously diagnosed malignant breast lumps were also not included in the study. All thirty-six patients underwent FNAC and mammography examinations. Most of the patients with malignant breast lumps underwent breast surgery at the TUTH. Some of the patients went to other centres for surgery. Excision biopsy for confirmation of FNAC diagnosis was carried out for 2 patients with ultrasonographically benign lesions and 12 malignant lesions.

Table 1. USG features of lumps

Dichotomized USG features		**Total**	**Palpable tumours (n = 36)**			
			Benign	**%**	**Malig**	**%**
Shape	Round/oval	18	17	94.0%	01	5.00
	Lob/irregular	18	0	0.0%	18	100.00
Outline	Well defined	20	18	90.0%	02	11.10
	Ill defined	18	0	0.0%	16	100.00
Vascularity	Normal	22	17	77.2%	05	22.70
	Increased	14	0	0.0%	14	100.00

Round and oval shape with well-defined margins was best predictor of benignity. Multiple lobulations, ill-defined margins and an increase in the vascularity were the key features of malignant lumps.

Table 2. Analysis of data – 1

USG Results	**FNAC Diagnosis**		**Total**
	Diseased	Not diseased	
Malignant	19 (True positive)	1 (False positive)	20
Benign	1 (False negative)	15 (True negative)	16
Total 36	20	16	36

Table 3. Validity of USG

Validity	**USG**
Sensitivity	95.00%
Specificity	94.10%
Accuracy	94.44%
Positive predictive value	95.50%
Negative predictive value	93.75%

Discussion

Usually, at the time of imaging examination, the radiologist evaluating a palpable breast abnormality is not informed of the degree of suspicion that the referring physician has regarding the palpable abnormality. Although the radiologist formulates his own opinion about the lesion, it would probably be useful to prospectively stratify lesions into categories on the basis of the referring physician's level of clinical suspicion. Stratifying the results of a physical examination into benign, indeterminate, or malignant categories has been used to refine the 'triple test', which uses mammography, physical examination and FNAC to evaluate palpable lesions. Morris et al[15] reported that stratifying each component of the triple test into the three categories would reduce the number of surgical biopsies performed on the benign lesions.

A similar system could be applied to patients undergoing mammography, sonography and physical examination as proposed by Winstein and Conant[5]. The smaller number of patients with highly suspicious lesions and negative imaging would require tissue sampling immediately. The larger group of less suspicious lesions would be placed into category of follow up physical examination. Patients with equivocal findings with physical examination and negative imaging findings could be reassured and in this subset, follow up would not be necessary.

This study was undertaken to calculate the predictive value of ultrasonography in patients presenting with palpable breast lumps. The sensitivity, specificity, positive and negative predictive values were statistically significant ($p = 0.0000006$) and were comparable to the values obtained by different studies conducted elsewhere).

Table 4. Sensitivity and specificity of ultrasonography in the diagnosis of palpable breast lumps

Source	No. Of patients	No. Of cancers	Sensitivity	Specificity
Englewood USA 1995	750	125	98.4%	NA
Yang et al Hong Kong 1996[17]	408	67	97%	97%
Royal Marsden UK 1990	60	23	96%	84%
This study	36	19	95%	94.11%

Table 5. Negative predictive value of ultrasonography in the diagnosis of palpable breast lumps

Source	No. of patients	Negative predictive value	Remarks
AT Stavros et al Radiology; 1995	750	99.5%	
P Skaane et al AJR 1998; 170[18]	336	100%	
Nottingham UK	205	99%	Palpable clinically benign lumps
MS Soo et al AJR 2001; 177[19]	420	99.8%	Combined US/mammography
This study	36	93.75%	

US features that most reliably characterize masses as benign were a round or oval shape with well-circumscribed margins with no central posterior shadowing or increase in vascularity. Features that characterize masses as malignant included irregular shape, microlobulations, and an increase in vascularity. In this study, a patient with a small lump with few smooth lobulations was diagnosed as benign by ultrasound. Mammography and FNAC showed the lump to be malignant. Retrospectively, the inferior margin of this small lump was seen to be ill defined. A combination of ultrasonographic features if used carefully, will help to achieve greater accuracy in the diagnosis of palpable breast lumps.

In this study, two patients with normal mammogram reports but USG features suggestive of malignancy underwent biopsy examination following FNAC. One patient with benign mammographic features but malignant USG features also underwent biopsy after

FNAC. All three patients had malignant lumps. The use of ultrasound in addition to clinical examination and mammography thus resulted in an increased rate of breast cancer detection.

Sonographic technology for breast imaging has dramatically improved in the past decade, as has an increased understanding of the findings associated with breast cancer. Higher frequency (13MHz) transducers are now available providing exquisite resolution of superficial structures and may prove optimal for imaging lesions in the breast. Tissue Harmonic imaging is another technical development that can improve lesion conspicuity and possibly lead to better sonographic detection of lesions[9]. With further improvement in sonographic equipment and careful prospective real time evaluation of palpable breast lumps, perhaps the negative predictive value will one day approach 100%. Ideally providing complete confidence for follow up rather than recommending biopsy of these lesions.

Conclusion

Ultrasound used liberally as an adjunct to mammography, increases the cancer detection rate by almost 15%. Ultrasound is not only useful in detecting malignancy not visible or not suspected on the mammogram but can also reduce the suspicion of malignancy in some patients although a pathological diagnosis should be obtained in all cases of lumps with suspicious clinical features.

Ultrasound is therefore recommended in all cases where there is a clinical suspicion of malignancy even if the mammogram is normal. Any focal mammographic or ultrasound abnormality should undergo needle biopsy.

Breast ultrasound does not expose the patient to ionizing radiation and with its relatively easy availability and cost effectiveness, it has already proven to be an important adjunct to the other radiological and pathological studies for the breast.

Improvements in US equipment have prompted more recent studies with findings that describe reliable signs for differentiating benign from malignant masses. However, it is important to determine if these results are reproducible when applied to practices with different US equipment, operator experience, interpreting physicians, and patient populations. It is also important to establish the interobserver variability in the assessment of these features, since this has not been reported.

Fig 1

Typical benign breast lump with round/oval shape; an echogenic pseudocapsule seen posteriorly. The lump is hypoechoic with homogeneous internal echoes. No central shadowing is seen posteriorly. Lateral edge shadowing is seen.
(FNAC- fibroadenoma)

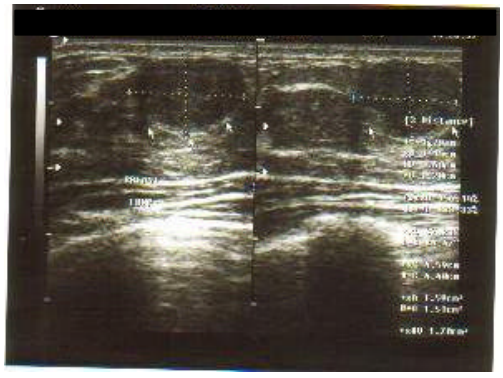
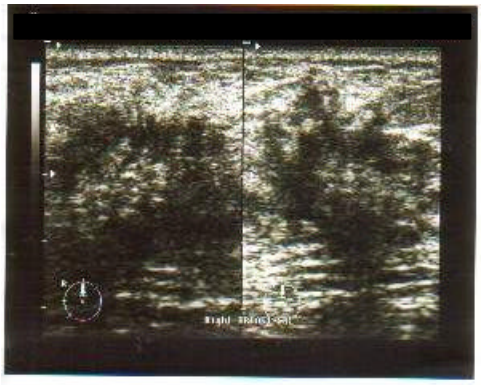


Fig 2

Typical malignant breast lump. Shows irregular lobulated shape and very ill defined margins. The lump is hypoechoic with heterogeneous internal echoes. An increase in vascularity is seen within the lesion.
(FNAC- Ductal carcinoma)



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