ORIGINAL ARTICLE

Ultrasound in the Assessment of the Palpable Breast Mass

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Summary

The aim of the study was: to obtain the profile of patients (with regards to age and family history of breast cancer) with a palpable breast mass. To determine the validity of ultrasound in the assessment of the palpable breast mass by determining the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in distinguishing a malignant mass. To determine the most discriminating ultrasound characteristics for differentiating benign and malignant masses. Seventy patients who had fine needle aspiration cytology of a palpable breast mass were subjected to an ultrasound assessment of the mass. The ultrasound findings were classified as benign, indeterminate or malignant. These findings were then compared with either the cytology or histology results in cases that eventually had surgical excision. The age of the patients ranged from 15 to 66 years old The majority was in the third and fourth decades with an average age of 25 years. The 8 patients with a proven malignant breast mass were aged between 39 and 66 years old. They did not have any family history of breast cancer. Only 4 patients had a family history of breast carcinoma and all proved to have a benign breast lesion. Ultrasound had a sensitivity of 100%, specificity of 85.7%, positive predictive value of 50%, negative predictive value of 100% and accuracy of 87.5% for distinguishing a malignant mass. For benign masses: 93.7% had well-defined margins, 81.3% had homogenous internal echoes, 91.7% had depth-width ratio of less than 1.0 and 89% were compressible. For malignant masses: 87.5% had either ill-defined or irregular margins, 87.5% had inhomogenous internal echoes and mixed posterior echoes, and 100% were incompressible. The majority of patients with a palpable breast mass were aged below 40 years old. Most of the patients with a malignant breast mass were aged 40 years and older. Neither a positive nor a negative family history of breast cancer had any significance on outcome. Ultrasound had high sensitivity, specificity and accuracy in distinguishing a malignant mass. The most discriminating benign ultrasound characteristic was compressibility. The most discriminating malignant ultrasound characteristic was ill-defined and irregular margins.

Key Words: Breast Mass, Malignant, Ultrasound

Introduction

The use of ultrasound to examine the breast was first described in 1951[1]. Since then, the ultrasound examination is well established as an important technique for the investigation of breast problems.

The most important role for ultrasound of the breast is differentiation between cysts and solid masses. When all criteria for a simple cyst are strictly adhered to, the accuracy of ultrasound is 96% to 100%[1-4]. This is not a trivial role because the use of ultrasound has greatly reduced the number of surgical excisions performed for benign cysts therefore saving patients the expense, anxiety and discomfort associated with surgery.

The other established role of ultrasound is the evaluation of a palpable mass not visible in a

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mammographically dense breast[1-3]. Normal density may either partly or completely obscure both benign and malignant breast masses.

The ultrasound examination is also used for evaluation of a young patient with a palpable breast mass[1-3]. Young breasts are more sensitive to radiation and breast cancer in this age group is relatively rare. It is desirable to limit the radiation exposure in young patients unless the woman has either a personal or strong family history of breast cancer [1].

Other roles of breast ultrasound include evaluation for abscess and guidance for interventional procedures. Ultrasound is an excellent method for the detection of an abscess cavity and it can guide either surgical or percutaneous drainage if necessary[1-3]. Ultrasound has been used successfully to guide percutaneous procedures such as cyst aspiration, fine needle aspiration cytology, core biopsy and wire localization of sonographically visible breast lesions.

Whether the use of ultrasound examination helps to differentiate a benign from malignant solid breast mass was one of the major controversies in breast imaging. A 99.5% negative predictive value for cancer has been reported [2]. This negative predictive value of over 99% is quite comparable to the negative predictive value of 98% in the mammographically benign nodule. The study demonstrated that high resolution ultrasound of the breast can successfully distinguish between benign and malignant solid nodules. Their findings suggest that follow-up of the solid but sonographically benign breast mass is a reasonable alternative to biopsy.

This study was aimed at determining the value of ultrasound in the assessment of the palpable breast mass. The profile of patients who presented with a palpable breast mass with regards to age and family history of breast cancer was obtained. The validity of ultrasound in the assessment of the palpable breast mass was determined by the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in distinguishing a malignant mass. The most discriminating ultrasound characteristics required in differentiating benign and malignant masses were determined by comparing the various ultrasound characteristics with either cytology or histology results in cases that eventually had surgical excision.

Materials and Methods

Patients

During the period of this study, it was the normal practice at the Breast Clinic, Hospital Universiti Kebangsaan Malaysia (HUKM) for patients complaining of a palpable breast mass to have fine needle aspiration cytology (FNAC). A pathologist performed the FNAC during the patients' first visit. The Breast Clinic was planned to run as a walk-in clinic where at the end of the first visit the patients would be told if they either had cancer or not. Subsequently, patients aged 35 years and older had mammography done.

For the purpose of this prospective study, patients with a palpable breast mass were offered ultrasound that was done either on the first or subsequent visit. The clinical, radiological and cytology findings were reviewed on follow-up to decide whether the patient required surgical excision of the mass to obtain a histological report.

Patients who did not get an ultrasound were excluded from the study.

Ultrasound Assessment

The ultrasound examination was done with an ALOKA SSD 1200 Ultrasound diagnostic equipment with a 7.5 MHz transducer. The same 3rd year radiology trainee performed all the ultrasound examinations. The ultrasound interpretation was made without knowledge of the cytology report.

The patients were examined in a supine position and turned slightly to the contralateral side with the ipsilateral upper limb extended cephalad and a pillow placed under the ipsilateral shoulder. This position flattens the breast symmetrically onto the chest wall. The palpable mass was scanned in longitudinal, transverse and radial planes. The clock-face was used to indicate the site of the mass.

The masses were evaluated according to their margins, internal echoes, posterior echoes, depth-width ratio and compressibility [2-7]. Each ultrasound finding was categorized as either benign or malignant (Table I). One point was given for each finding. The total number of benign and malignant findings was tallied. The percentage of malignant findings was calculated as a percentage of the total. If no malignant findings were

found, the lesion was classified as benign. If there were either 49% or less malignant findings, the lesion was classified as indeterminate. Those with either 50% or more malignant findings were classified as malignant.

The ultrasound findings were then compared with either cytology or histology results in cases that eventually had surgical excision.

Results

1. Profile of patients with a palpable breast mass
Seventy patients aged between 15 and 66 years had presented with a palpable breast mass. The majority of patients (68.6%) were in the third and fourth decades with an average age of 25 years. The 8 patients with a malignant breast mass were aged between 39 and 66 years. These 8 patients had no family history of breast cancer. Only 4 patients (7%) with a palpable breast mass had a family history of breast carcinoma and all of them had a benign breast lesion.

2a. Ultrasound findings of the palpable breast mass
The majority of lesions had benign ultrasound findings (Table II). Of the 70 palpable lesions, ultrasound did not reveal a mass in 14 cases (20%). Based on ultrasound findings these 14 cases were classified as benign.

2b. Cytology and histology results
A comparison of the ultrasound findings with the cytology and histology results of the palpable breast mass is shown in Table III. Of the 54 lesions classified as benign on ultrasound, 48 (88.9%) were confirmed benign and 6 (11.1%) were inconclusive due to inadequate specimen for evaluation. These inconclusive cytology results were from the 6 out of 14 cases where ultrasound did not reveal a mass. The cytology of the remaining 8 cases where ultrasound did not reveal a mass was reported as benign breast lesion.

There were 7 (10%) breast lesions classified as indeterminate based on ultrasound examination. Of these, one case had a cytology result that was suspicious of malignancy, and 6 cases were confirmed benign. The patient with a cytology result that was suspicious of malignancy had defaulted follow-up.

The ultrasound findings had detected 9 (12.9%) malignant lesions. Of these, 7 were confirmed malignant on cytology and 2 cases were benign. Of the 7 malignant cases, 6 had infiltrating ductal carcinoma and 1 had mucinous carcinoma on histology. Of the 2 cases with benign cytology, one was diagnosed as fibroadenoma and this was confirmed on surgical excision. The other patient was diagnosed to have a benign proliferative breast lesion and was placed on follow-up at the Breast Clinic.

None of the breast lesions classified as benign on ultrasound proved to be malignant on cytology.

For the purpose of calculating sensitivity, specificity, positive predictive value negative predictive value and accuracy of ultrasound in distinguishing a malignant lesion, the ultrasound findings and cytology/histology results were re-grouped (Table IV). The lesions classified on ultrasound as indeterminate and malignant were grouped together. The lesions classified on cytology/histology as suspicious of malignancy and malignant were grouped together. The lesions with inconclusive cytology results were excluded.

2c. Validity of ultrasound in the assessment of a palpable mass
Ultrasound had a sensitivity of 100%, specificity of 85.7%, positive predictive value of 50%, negative predictive value of 100% and accuracy of 87.5% for distinguishing a palpable malignant mass.

3a. Ultrasound characteristics seen in confirmed benign masses
The ultrasound characteristics seen in confirmed benign masses are shown in Table V. Of the confirmed 48 benign lesions, ultrasound did not detect a mass in 8 cases. However, 6 classified as indeterminate and 2 classified as malignant on ultrasound proved to be benign. Therefore a total of 48 masses detected on ultrasound proved to be benign. The majority of benign masses had well-defined margins, had homogenous hypoechoic internal echoes and showed posterior enhancement. The majority also had D/W ratio of less than 1 (wider than tall) and were compressible.

3b. Ultrasound characteristics seen in confirmed malignant masses
The ultrasound characteristics seen in confirmed malignant masses are shown in Table VI. Of the malignant masses, 7 had either ill-defined or irregular

margins except 1 case of mucinous carcinoma that had well-defined margins. Two lesions with irregular margins also showed an echogenic rim. Seven nodules had inhomogeneous internal echoes and exhibited mixed posterior acoustic enhancement and shadowing except the 1 case of mucinous carcinoma that had hypoechoic internal echoes and posterior enhancement. Only 4 lesions had D/W ratio of greater than 1.0 (taller than wide). All 8 confirmed malignant breast lesions were incompressible.

3c. The most discriminating ultrasound characteristics required in differentiating benign and malignant masses

The most discriminating benign ultrasound characteristic was compressibility that had a negative predictive value of 100%. The most discriminating malignant ultrasound characteristic was ill-defined and irregular margins that had a positive predictive value of 70%.

Table I: Benign and Malignant Ultrasound Characteristics

Ultrasound Characteristics	Benign Ultrasound Characteristics	Malignant Ultrasound Characteristics
1. Margin	- Well-defined	- Ill-defined
	- Smooth	- Irregular
	- Lobulated	- Echogenic rim
2.Internal echoes	- Homogeneous	- Inhomogeneous
	- Anechoic	
	- Hypoechoic	
3. Posterior echoes	- Enhancement	- Shadow
	- No change	- Mixed (enhancement & shadow)
4. Depth / Width (D/W) ratio (ratio of the anteroposterior diameter to the width of the lesion).	Less than 1	1 or greater
5. Compressibility	Compressible	Incompressible

Table II: Ultrasound Findings of the Palpable Breast Mass

Ultrasound findings	Number of patients (%)
Benign	54 (77.1%)
Indeterminate	7 (10.0%)
Malignant	9 (12.9%)
Total	70 (100%)

Table III: Comparison of Ultrasound Findings With Cytology / Histology Results

Ultrasound findings	Cytology / Histology results			
	Benign	Inconclusive	Malignant*	Total
Benign+	48	6	-	54
Indeterminate	6	-	1	7
Malignant	2	-	7	-
Total	56	6	8	70

* malignant & suspicious of malignancy

\+ benign & no mass detected

Table IV: Validity of Ultrasound in the Assessment of a Palpable Mass

Ultrasound findings	Cytology/Histology findings		Total
	Benign	Malignant*	
Benign+	48 (TN)	- (FN)	48
Malignant#	8 (FP)	8 (TP)	16
Total	56	8	64

Note- FN = false negative, FP = false positive, TN = true negative, TP = true positive
Sensitivity = TP/(TP+FN) = 8/(8+0) = 100%
Specificity = TN/(TN+FP) = 48/(48+8) = 48/56 = 85.7%
Positive predictive value = TP/(TP+FP) = 8/(8+8) = 8/16 = 50%
Negative predictive value = TN/(TN+FN) = 48/(48+0) = 100%
Accuracy = (TP+TN)/(TP+TN+FP+FN) = (8+48)/(8+48+8+0) = 56/64 = 87.5%.

* malignant & suspicious of malignancy
\# malignant & indeterminate
\+ benign & no mass detected

Table V: Ultrasound Characteristics Seen in Confirmed Benign Masses

Ultrasound Characteristics	Benign Ultrasound Characteristics	Number of Confirmed Benign Lesions (%)	Malignant Ultrasound Characteristics	Number of Confirmed Benign Lesions (%)
1. Margin	Well-defined	45 (93.7%)	Ill-defined	3 (6.3%)
	Smooth	35 (72.9%)	Irregular	-
	Lobulated	8 (16.7%)	Echogenic rim	2 (4.2%)
2.Internal echoes	Homogeneous	39 (81.3%)	Inhomogeneous	9 (18.7%)
	Anechoic	4 (8.3%)		
	Hypoechoic	35 (72.9%)		
3. Posterior echoes	Enhancement	36 (75%)	Shadow	1 (2%)
	No change	6 (12.5%)	Mixed	5 (10.4%)
4. D/W ratio	Less than 1	44 (91.7%)	1 or greater	4 (8.3%)
5. Compressibility	Compressible	43 (89%)	Incompressible	5 (10.4%)

Table VI: Ultrasound Characteristics Seen in Confirmed Malignant Masses

Ultrasound Characteristics	Benign Ultrasound Characteristics	Number of Confirmed Malignant Lesions (%)	Malignant Ultrasound Characteristics	Number of Confirmed Malignant Lesions (%)
1. Margin	Well-defined	1 (12.5%)	Ill-defined	4 (50%)
	Smooth	-	Irregular	3 (37.5%)
	Lobulated	-	Echogenic rim	2 (25%)
2. Internal echoes	Homogeneous	-	Inhomogeneous	7 (87.5%)
	Anechoic	-		
	Hypoechoic	1 (12.5%)		
3. Posterior echoes	Enhancement	1 (12.5%)	Shadow	-
	No change	-	Mixed	7 (87.5%)
	Shadow			
4. D/W ratio	Less than 1	4 (50%)	1 or greater	4 (50%)
5. Compressibility	Compressible	-	Incompressible	8 (100%)

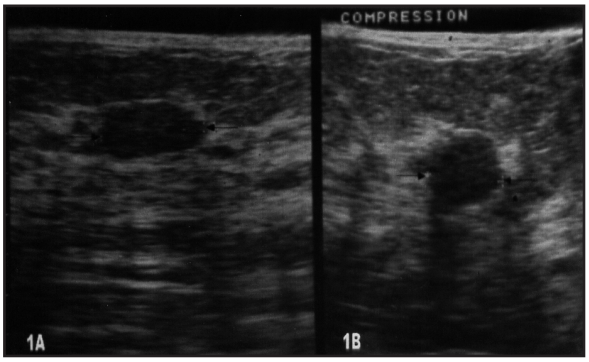

Fig. 1: (A) This lesion (arrows) has well-defined smooth margins, homogenous hypoechoic internal echoes, no change in posterior echoes and a depth/width ratio of less than 1. (B) Side-to-side compression shows the oval lesion has been compressed to a rounded form (arrows). This lesion proved to be a fibroadenoma.

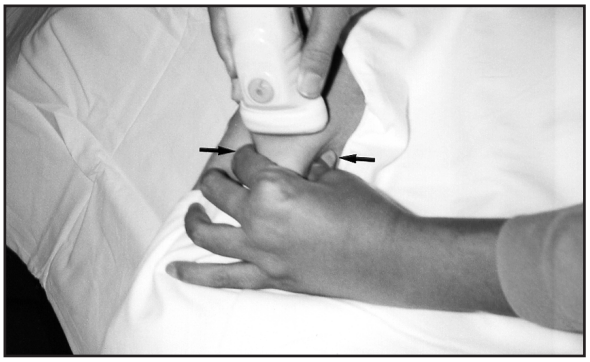

Fig. 2: Test for compressibility. With one hand holding the transducer over the lesion, the free hand is used to apply compression using the thumb and index finger (arrows). Side-to-side compression is applied along the same plane of the image.

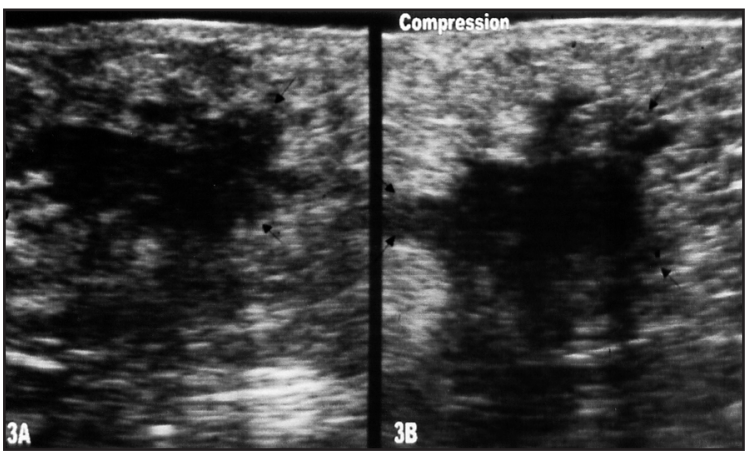

Fig. 3: (A) This lesion (arrows) has irregular margins, inhomogenous internal echoes, mixed posterior echoes showing enhancement and shadowing and a depth/width ratio of less than 1. (B) Side-to-side compression shows no significant change in width along the plane of compression although the depth of the lesion has changed (arrows). This lesion was considered incompressible and proved to be infiltrating ductal carcinoma.

Discussion

The majority of patients presenting with a palpable breast mass in our study were young women. There were 48 (68.6%) patients in the third and fourth decades. The majority (97.8%) had benign breast lesions. Eight patients with a malignant breast mass were aged 39 to 66 years. This age of incidence of benign and malignant breast disease was consistent with other series [6,7].

Women over 40 years old have a greater risk of developing breast cancer and the incidence increases progressively until the age of 70[8]. Less than 0.3% of breast cancer occurs in women under the age of 30. A mass in a woman in this age group is almost invariably a benign breast lesion[6,7]. Younger women are more sensitive to the potential negative effects of ionizing radiation. Therefore in patients with a palpable breast mass who are under the age of 30 years and are not at risk because of a strong family history of breast cancer, ultrasound and not mammography should be the initial imaging modality [1-3]. However, the value of ultrasound as a screening tool in young asymptomatic women is not justified because the incidence of breast cancer in this age group is very low [6,7].

The analysis of the epidemiology of breast cancer has identified several factors associated with the increased risk of breast cancer and these include: early age of menarche, later age of menopause, nulliparity, late age of first pregnancy, obesity, high dose exposure to radiation, not breast feeding, history of benign breast lesion, alcohol consumption, a diet high in animal fat and family history of breast cancer[7]. Majority of factors are not particularly of high risk and are generally associated with a relative risk of less than 3.0[7]. Family history is generally reported as among the more important risk factor associated with breast cancer. For women with a family history of breast cancer in both a mother and a sister, the adjusted relative risk is 13.6 [7]. In our study, 4 patients (7%) with a palpable breast mass and a family history of breast cancer proved to have a benign breast mass. Eight patients with a malignant breast mass had no family history of breast cancer. However, these findings are not statistically significant because of our small study population.

The role of ultrasound in the assessment of the clinically palpable breast mass has until recently been limited to differentiating cysts from solid lesions [1-3]. Improvement in ultrasound technology has recently led to a number of reports of accurate benign/malignant differentiation using ultrasound [2-7]. Ultrasound may be considered an extension of the physical examination of the breast. This is because the ultrasound transducer can be placed directly over the palpable lesion to see if the 'lump' felt either is a discrete mass or otherwise. Patients with benign breast change / fibrocystic change may feel either a lump or lumpiness. However, on ultrasound there would not be any discrete mass and FNAC would show benign breast change. Fat lobules that are normally present within the breast may also feel lumpy. Once again ultrasound would not show any discrete mass. FNAC in this case would reveal mainly fat cells with lack of epithelial cells. Since the pathologist needs to look at epithelial cells to make a reasonable conclusion, the FNAC would be reported as inconclusive cytology due to inadequate specimen for evaluation. This was the case in our series where ultrasound did not reveal a mass in 14 cases. The FNAC of 8 cases were reported as benign breast lesion and 6 cases were reported as inconclusive.

In our assessment of the palpable breast mass, the sensitivity of ultrasound was 100%, specificity was 85.7% and accuracy was 87.5% for differentiation of a malignant mass. The positive predictive value was 50% and the negative predictive value was 100%. These results are comparable with previous series[4-9]. A study of symptomatic and screen-detected lesions indicated a sensitivity of 98% and specificity of 68%[2].

Our study showed the majority of benign masses had the following features: well-defined margins, homogeneous internal echoes, posterior echo enhancement, D/W ratio of less than 1.0 and compressibility (Figure 1A & 1B). These results are comparable with previous studies that reported majority of fibroadenoma showed well-defined margins[10], homogenous internal echoes[11], posterior enhancement because homogenous cellularity allowed enhanced ultrasound transmission[2,9], D/W ratio of less than 1.0 because growth is along normal tissue planes [5], and compressibility[5,12].

The test for compressibility should be well executed. The lesion should be compressed in the same plane as the transducer, using the thumb and index finger of the free hand (Figure 2). Vertical up and down compression using the transducer is an inaccurate assessment of compressibility because all tissue beneath the transducer would move.

Our study showed the majority of malignant masses had the following features: either ill-defined or irregular

margins, inhomogenous internal and posterior echoes and incompressibility (Figure 3A & 3B). These results are comparable with previous studies that reported majority of malignant masses showed indistinct margins due to infiltration of the tumour into the surrounding tissues[2], inhomogenous internal echoes[11], inhomogenous posterior echoes[2,13], and incompressibility [5].

In our series one case of mucinous carcinoma showed well-defined margins, hypoechoic internal echoes and posterior enhancement. Mucinous carcinoma is known to show smooth and sharply demarcated margins [8,9]. Other circumscribed carcinoma includes medullary and papillary carcinoma[8]. However, the likelihood of malignancy for a completely well-defined circumscribed mass of 1.0cm or less is extremely low [8]. Tumours that either contain mucin or are highly cellular such as medullary and papillary carcinoma often show normal to enhanced posterior echoes rather than shadowing [2,7,8].

Incompressibility is a feature that is particularly useful in the diagnosis of well-circumscribed carcinoma that may simulate benign lesions such as our one case of mucinous carcinoma. This feature is also useful for malignant masses with the same reflectivity as surrounding tissues (isoechoic lesions) that are easily overlooked [5]. In our series, all the malignant lesions were incompressible.

In evaluating the benign and malignant ultrasound characteristics of the breast mass attention must be paid to several imaging characteristics rather than a single feature. Often, evaluation of wall characteristics, the internal and the posterior echoes together with the patient's clinical history is usually sufficient for accurate diagnosis [2-7].

In a colour Doppler study of breast masses, it was reported that subjective evaluation revealed colour signals were more commonly found in malignant (89%) than benign (56%) lesions[14]. Doppler ultrasound demonstrated that extensive colour signals (indicating a highly vascular lesion) were suspicious for malignancy. However, infection has to be considered as a differential diagnosis[15]. For lesions that show few colour signals, either benign breast change or fibroadenoma must be considered as the differential diagnosis. It was concluded that colour Doppler signals in lesions otherwise thought to be benign should prompt a biopsy, while the absence of signals in an indeterminate lesion is reassuring[14,15]. We did not assess the breast mass with colour Doppler.

The current practice at the Breast Clinic, HUKM is for all patients with a palpable lesion to have either ultrasound (if below 35 years old) or mammography (if 35 years old and above) before FNAC. For those below 35 years old, if both the ultrasound and FNAC are benign, the ultrasound and FNAC are repeated after 3 months. If the repeat examinations again prove benign the patient is discharged. For those above 35 years, if both mammography and FNAC are benign, the patient will be scheduled for surgical excision at a later date. Malignancy suspected either from clinical, radiological or cytology findings would mean an early surgical excision.

In summary, this study shows that ultrasound is valuable in the characterization of the palpable breast mass. The palpable breast mass is a common problem especially in young women. In a busy hospital, ultrasound is a useful tool to screen and identify patients who require early surgical excision and those who require follow-up only. There is no physical hazard to the patient and the procedure is comfortable and well tolerated. However, it must be emphasized that the following are essential: excellent ultrasound technique, optimal machine and transducer and strict adherence to the criteria for benign lesions that require the absence of even a single malignant finding. The use of ultrasound for the initial imaging of a palpable mass would result in improved health care, reduction of patient discomfort due to unnecessary surgical excision and reduction in morbidity.

Conclusion

The average age of patients with a palpable breast mass was 25 years old. The patients with a malignant breast mass were aged between 39 and 66 years old and they did not have any family history of breast cancer. Four patients with a family history of breast cancer had benign lesions. Ultrasound had high sensitivity (100%), specificity (85.7%) and accuracy (87.5%) in distinguishing a malignant mass. The most discriminating benign ultrasound characteristic was compressibility. The most discriminating malignant ultrasound characteristic was ill-defined and irregular margins.

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