

DIAGNOSTIC ACCURACY OF POWER DOPPLER ULTRASONOGRAPHY IN MALIGNANT BREAST MASSES

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ABSTRACT

OBJECTIVE: To determine diagnostic accuracy of power Doppler ultrasonography in evaluation of solid breast mass lesions for malignancy keeping histopathology as gold standard. **MATERIALS AND METHODS:** The study was done in radiology department combined military hospital Rawalpindi from 1st July 2018 to 30th June 2019 using Xario 200 Toshiba ultrasound machine with high frequency probe. Those patients with palpable breast mass referred to radiology department for breast ultrasonography fulfilling inclusion criteria were registered in the study. Informed consent was taken from all patients. The power Doppler ultrasound of breast of all patients were performed and findings were analyzed by two consultant radiologist in double blind interpretation. All included patients followed a trucut biopsy of breast mass. Power Doppler and histopathological findings were noted on a dedicated performa. At the end, data was put in 2x2 table to calculate statistical values. **RESULTS:** Total 202 patients were studied during the study period. Age range of patients in this study was from 30-60 years. Power Doppler ultrasound findings supported the diagnosis of malignant breast mass lesions in 130 patients. Among which ,113 were true positive and 17 were false positive on histopathology. Among 72 power Doppler negative patients for malignancy, 14 were false negative whereas 58 were true negative on histopathology. The sensitivity, specificity, diagnostic accuracy, positive predictive value and negative predictive value of power Doppler ultrasound in predicting malignancy in evaluation of solid breast lesions was 88.97%, 77.33%, 84.65%, 86.92% and 80.55% respectively. **CONCLUSION:** The peculiar vascular pattern in malignant breast masses are very effectively detected by power Doppler ultrasound. So it should be included as integral part of every sonomamographic examination of solid breast lesions.

Keywords: Breast mass, power Doppler ultrasound, hypervascularity, penetrating vessels.

Introduction

Around the world most common malignancy in females is breast cancer. The breast cancer incidence and mortality varies by region to region worldwide. Its incidence is noted highest in developed countries and lowest in developing countries however it is increasing in latter.¹ It is the second leading cause of cancer mortality in females in United States at present.² Prognosis of breast cancer could only be better if diagnosed early. For early diagnosis and

follow up, imaging provides a crucial role. Imaging guided biopsy is considered superior to surgical biopsy in terms of convenience, cost and invasiveness.

The sonomamography is noninvasive, safe and easily available investigation which has a key role in diagnosis as well as in management of breast cancer. Reliability of sonomamography may further be increased if vascular characteristics of breast mass lesion are taken in consideration by power Doppler

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ultrasound. Malignant breast masses have certain peculiar vascular features like hyper vascularity, tortuosity of arteries, central pattern of vascular distribution and presence of penetrating arteries. There is a correlation between new vessels formation and cancer cells which was first highlighted by Folkman in 1971.³ Rapidly multiplying cancerous cells require oxygen in excess and hence stimulate neoangiogenesis towards tumor from existing blood vessels of parent tissues. Therefore the study of tumor vascularity can be useful to discriminate between malignant and benign breast masses.^{4,5}

The objective of this study is to highlight the role of power Doppler in differentiating malignant from benign breast masses by studying the features of their vascular pattern taking histopathology as gold standard. Power Doppler is preferable to color Doppler as former is less angle / movement dependent and having more sensitivity to blood flow. The result of study will surely add a further step in early diagnosis and management of breast cancer.

Material and Methods

The study was conducted at radiology department, combined military hospital (CMH) Rawalpindi from 1st July 2018 to 30th June 2019. Study was approved by ethical review committee of hospital. The study was done on toshiba xario 200 color doppler ultrasound machine equipped with high frequency (6 to 10 MHz) probe. It is a cross sectional validation study.

Inclusion criteria: All those patients aged between 30 to 60 years having palpable solid breast mass referred to radiology department for breast ultrasonography was selected in study after scrutiny through exclusion criteria.

Exclusion Criteria: All those patients having cystic breast lesions, history of previous breast surgery, refusal to give study consent, lost to follow up, refused biopsy of lesion, inconclusive histopathological findings of biopsy and history of hormonal / chemotherapy for the breast lesion are excluded from the study.

Informed consent explaining details and benefits of study were taken from all patients. The study was

started after taking approval from hospital ethical committee. The power Doppler and grey scale ultrasound was performed and findings analyzed by two consultant radiologists blindfolded to each other findings. Only those cases were included in study, on which both radiologist having agreement of opinion. The complete privacy of patient data and findings were ensured.

The target /positive finding on power Doppler was to find hyper vascularity (more than two arteries in the lesion) or central distribution of vessels or presence of penetrating artery within the mass lesion. The case is labeled positive for malignancy if one of the above color Doppler finding is present. The lesions which are avascular or hypo vascular (1-2 arterial vessels in lesion) or only having capsular vessels are taken as benign lesions. BI-RADS grading was not taken in consideration in the study. In addition to Doppler sonographic finding, age, serial number, duration of disease and hospital ID were also noted on a dedicated performa. Later all the patients went through trucut biopsy of lesion with 18G needle by consultant radiologist and specimen sent for histopathology examination. The histopathology finding was also recorded on same patient's performa. At the end of study, data was entered and analyzed in 2x2 table to calculate statistical values. Sensitivity, specificity diagnostic accuracy, positive predictive value and negative predictive value for power Doppler ultrasound against histopathology findings were calculated.

Results

Total 202 patients were studied during study period. Age range of patients was from 30-60 years with 47.48 years being the mean age among patients. Substantial number of the patients (44.14%) aged between 40-50 years (Fig. 1).

Every patient in study was evaluated with power Doppler ultrasound for solid breast mass lesion. Power Doppler ultrasound findings supported the diagnosis of malignant breast mass lesions in 130 (64.35%) patients. Among these 130 ultrasound positive patients for malignancy, 113 had malignant breast lesions (true positive) and 17 had benign lesion on histopathology findings (false positive). The remaining 72 patients (35.64%) were labeled negative for malignancy.

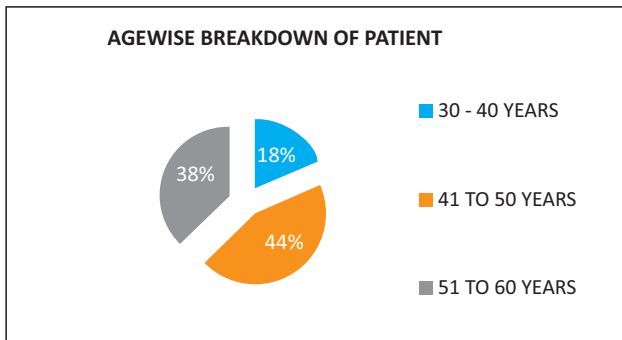


Figure 1: Distribution of patients according to age

nancy on power Doppler ultrasound. Among these patients, 14 showed malignant breast lesions on histopathology (false negative) whereas remaining 58 patients were confirmed benign mass lesion on histopathology (true negative) as shown in (Fig. 2). Overall sensitivity, specificity, diagnostic accuracy, positive predictive value and negative predictive value of power Doppler ultrasound in predicting malignancy

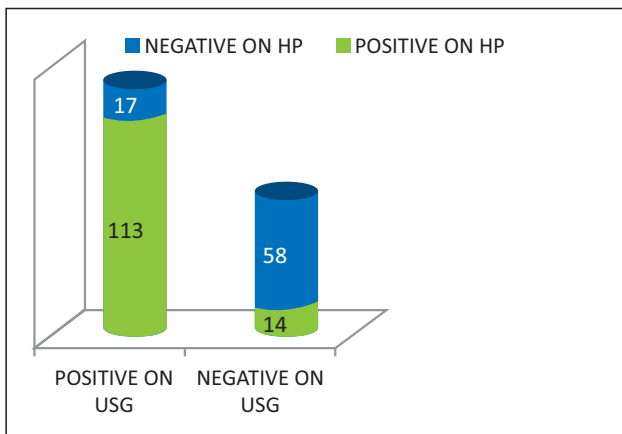


Figure 2: Breakdown of cases for malignancy on power Doppler and histopathology

	Positive result on Histopathology	Negative result on Histopathology
Positive on power Doppler USG	113 (TP)*	17 (FP)**
Negative on power Doppler USG	14 (FN)***	58 (TN)****

*-TP= (True positive) **-FP= (False positive) ***-FN= (False negative) ****-TN= (True negative)
 Sensitivity: 88.97%
 Specificity: 77.33%
 Diagnostic Accuracy: 84.65%
 Positive Predictive Value: 86.92%
 Negative Predictive Value: 80.55%

Table 1: Diagnostic accuracy of power Doppler ultrasound in predicting malignancy in evaluation of solid breast lesions taking histopathology as gold standard.

in evaluation of solid breast lesions was 88.97%, 77.33%, 84.65%, 86.92%, and 80.55% respectively (Tab. 1).

Discussion

Worldwide the leading cause of mortality is cancer. Breast cancer has a highest incidence and is among the most common cancers in the world. According to Globocan, in 2012 alone nearly 1.7 million females were diagnosed with breast malignancy leading to it being the most common cause of cancer in women worldwide. Its standardized incidence rate is 43.1 per 100,000. The largest incidence rate was seen in Belgium (111.9), and the smallest rate was seen in Mongolia and Lesotho (9). It also accounts for 25.1% of all malignancies.⁶ Breast cancer is also one of the commonest woman malignancy in our country. The data of breast cancer statistics in Karachi alone illustrates the proportion of breast cancer to be 69.1 per one million out of which most of the cases were in late stages.⁷ In another local study, highest incidence was noted in Lahore contributing up to 46% of breast cancers cases in Punjab.⁸

Cancer cells being rapidly and un-controlling growing require more oxygen and nutrients. This causes growth of new blood vessels from parent normal tissues into abnormally growing cell mass. This results in hyper vascularity and abnormal vascular pattern in any malignant mass including breast malignant mass lesions. Abnormal vascular pattern in malignant breast mass lesion includes hyper vascularity (arterial vessels more than two), penetrating vessels [arterial vessel going into malignant mass without a capsular course, (Fig. 3)], tortuosity of vessels and central distribution pattern. This vascular pattern if studied by power Doppler in breast mass lesion, the prediction about nature of mass whether malignant or benign can be done. The power Doppler is preferable to conventional color Doppler in this regard as having more sensitivity to blood flow and less angle/ movement dependent. The power Doppler is found to be having 2-5 times more sensitivity compared to color Doppler in breast ultrasound.^{9,14} We compared our power Doppler ultrasound findings of our study cases with histopathology results of biopsy. The sensitivity, specificity, diagnostic accuracy, PPV and NPV of power Doppler ultrasound of our study in predicting



Figure 3: Intraductal carcinoma right breast at 12 o clock position showing penetrating artery

malignancy for evaluation of solid breast lesions was 88.97%, 77.33%, 84.65%, 86.92% and 80.55% respectively. Our results showing high sensitivity, PPV and diagnostic accuracy, are very encouraging. Even specificity and NPV are also very good.

Raza and Baum first described the morphology of the vessels of solid breast lesions on power Doppler ultrasound. They found that sensitivity, specificity, NPV and PPV using penetrating vessels of solid breast mass to predict malignancy were reported to be 68%, 95%, 88% and 85%, respectively.¹⁰ Except sensitivity and specificity, other statistical values are closer to our study, it may be due to fact that we did study on relatively better Doppler ultrasound equipment. In another study by Kook SH and colleagues, power Doppler findings were contrasted with conventional color Doppler. Power Doppler sonography showed superiority of flow in 61 study patients (60%) and equal in 41 study patients (40%). On power Doppler sonography, the incidence of increased vascularity in malignant lesions (65%) was higher than that in benign lesions (39%). The study also noted further details of blood flow in breast masses. The morphology of vascularity was central (86%) and penetrating (65%) mostly in malignant lesions than in benign lesions (51% and 34%, respectively). Branching (56%) and disordered vessels (42%) were seen mostly in malignant lesions than in benign lesions (22% and 8%, respectively). The sensitivity, specificity, and accuracy in diagnosing malignancy for power Doppler sonography were 64%, 76%, and 71% respectively. They concluded that power Doppler

sonography was more sensitive than color Doppler sonography in the detection of blood flow in solid breast lesions.¹¹ Tozaki and colleagues did a study in 2011 and found that power Doppler ultrasound can increase the Bi-RADS category of breast masses from category 3 to 4a. They concluded that power Doppler increases the malignancy pick up rate on the presence of blood flow in the mass.¹² The same fact was highlighted by us that power Doppler assessment of breast masses increases pick up rate of malignancy.

In a study by Gokalp G on usefulness of power Doppler ultrasound in assessment of breast masses, the sensitivity, specificity, PPV and NPV of simple grey-scale ultrasound with power color Doppler ultrasound in the detection of malignant lesions were approximately 100%, 59%, 63%, 100% and 72%, 82%, 74%, 80.%, respectively. However their conclusion pointed that power Doppler ultrasound has no additional contribution to improve BIRADS category of lesion.¹³ This study results were however in contradiction and lower to our study results. In another study by Ibrahim in 2016 on 102 cases of breast masses, found the sensitivity, specificity, PPV and NPV of the presence of penetrating vessels within the lesion in predicting malignancy were 76.5%, 80.0%, 76.5% and 80.0% respectively.¹⁴ However the values are slightly less than our study but it may be due to single criteria of penetrating vessels as they had taken where as we have taken hyper vascularity and central distribution of vessels as additional criteria as predictors for malignancy in our study.

A study was done by Yasmin Davoudi and colleagues in Tehran in 2013 on usefulness as well as effectiveness of color Doppler ultrasound in critical differentiation between benign lesions and malignant lesions. She found hyper vascularity as a main predictor of malignancy in breast masses. She found hyper vascularity in 97.4% in malignant masses which is a very significant percentage and supporting our study results.¹⁵ A study done by Kanika Gupta and colleagues in 2017. They found hyper vascularity in 77%, tortuosity of vessels 72% and penetrating vessels in 62% cases of malignant breast mass lesions in their study.¹⁶

All this review of literature, revealing the fact that Doppler ultrasound especially power Doppler, has a very encouraging role in detecting peculiar vascular

pattern of malignant breast masses like hyper vascularity, central distribution of vessel and penetrating vessels which can be used as predictors for malignancy. This fact supports the result of our study and also emphasizing the fact that power Doppler should be part of every sonomammographic evaluation of breast masses.

Conclusion

It is concluded that peculiar vascular pattern of malignant breast masses are effectively detected by power Doppler ultrasound so it should be integral part of all breast ultrasound examinations for evaluation of solid mass lesions.

Conflict of Interest: Declared none by authors

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