# USEFULNESS OF RESISTIVE INDEX TO DIFFERENTIATE BENIGN FROM MALIGNANT BREAST LESIONS USING COLOR DOPPLER ULTRASOUND

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## ABSTRACT

**Objectives:** The aim of the study is to analyze the usefulness of resistive index in differentiating benign lesions from malignant breast lesions among suspected breast cancer patients using color Doppler ultrasound.

**Method:** The study was conducted in the Department of Diagnostic Radiology in Lahore General Hospital, from March 2022 to May 2022. Prospective cross-sectional study and convenient sampling technique was used. Total 200 patients suspected of Breast cancer after clinical examination were included in the study. Color Doppler ultrasound was performed. Systolic peak and resistive index were evaluated for each patient and results were compared with biopsy and cytology reports.

**Results:** From the results of color Doppler ultrasound, 86 lesions were found malignant and 114 breast lesions were found benign. From findings mean value of RI in malignant lesions was 0.76 ± 0.092 and in benign lesions was 0.64 ± 0.064. Statistical significance was found 0.05. It was also observed that benign breast lesions showed less vascularity in comparison to high vascularity in malignant breast lesions. Increased vascularity in benign lesions was 37.7% and in malignant lesions was 96.5%. Systolic velocity and systolic peak were low in benign lesions and in malignant lesions high systolic velocity and sharp systolic peak was observed.

**Conclusion:** In developing countries where public health screening programs are not sufficiently available, color and spectral Doppler ultrasound has an important role in early detection of breast cancer. It is a noninvasive imaging technique. Resistive index, systolic peak and hyper vascularity are useful indicators for differentiating benign lesions from malignant breast lesions.

**Keywords:** Breast Cancer, Resistive Index, Color Doppler Ultrasound, Early Detection

**How to cite this article:** Alavi SR, Raheel N, Yasin A, Ameer S . Usefulness Of Resistive Index to Differentiate Benign from Malignant Breast Lesions Using Color Doppler Ultrasound**.** Pak Postgrad Med J 2025;36(1):



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*Received: November 16,2022; Revised: May 05,2023*
*Accepted: March 27,2024*

DOI: https://doi.org/10.51642/ppmj.v36i01.514

## INTRODUCTION

Breast cancer is common among women and is a major cause of mortality worldwide. 2.1 million cases were registered in the year 2018 alone and the deaths were 627,000. Among Asian countries breast cancer rate is high in Pakistan. It is said that from every nine women one woman has the chance of getting breast cancer. [1] A considerably higher death rate has been observed because of lack of knowledge, leading to delayed diagnosis and treatment. [2] Early diagnosis of breast cancer can reduce the morbidity and mortality among women.

Tremendous upgradation in imaging modalities has made early diagnosis easy. Mammography was considered first line screening method in the past. There were many disadvantages of mammography like it has radiation risk for pregnant, young women and have low sensitivity in cases of dense breast up to 38%. With the advanced ultrasound technology and its high diagnostic accuracy, color Doppler ultrasound is being applied

considerably in oncology for early detection of breast cancer among women accurately. [3]

There are many imaging techniques available and in practice but color Doppler due to exploration of flow parameters and vascularity has enhanced the diagnostic accuracy. Parameters which were used to differentiate the malignant lesions from benign are resistive index, systolic flow velocity and pulsatility index. Sensitivity and specificity of color Doppler ultrasound is high in detecting malignant from benign lesions. [4]

MRS and MR mammography are now being used as non-invasive techniques and are more sensitive in diagnosing breast cancers. But they are costly, not readily available and not suitable for claustrophobic patients.

The aim of this study was to diagnose breast lesions on color doppler ultrasound on the basis of resistive index and systolic peak by entertaining every patient coming with complain of breast lump, as it is readily available in virtually all local setups and is cost effective.

## METHODS

This Prospective cross-sectional study was conducted in the Department of Diagnostic Radiology of Lahore General Hospital from March 2022 to May 2022. Sample size for the study was 200 women referred from breast clinic with palpable breast lumps, who were willing to participate in the study. Informed written consent from the patients was obtained.

Sample size was calculated by using formula $n= z^2P(1-P)/d^2$, where z=1.96, P=16% and d=5. [5] P value was obtained from a recent large local study conducted in Southern Punjab, which showed prevalence of different breast lesions among women of all ages. [6]

**Inclusive Criteria:**

- Female age group from 20 years to 65 years
- Having palpable or solid space breast lesion

**Exclusion criteria:**

- Pregnant women
- History and operation of breast cancer

**Color Doppler Ultrasound Protocol:** Supine position was used to position the patients and were turned slightly to the opposite side. The ipsilateral arm was extended above head and a pillow was placed under ipsilateral shoulder for analyzing breast parenchyma over anterior chest wall. Other arm was placed behind the head. The palpable breast mass was scanned in transverse, radial and longitudinal planes. The clockface was used to describe the exact position of the mass. Linear transducer with frequency 9MHz of Logic S8 was used for scan. Time for scan was 10-15 minutes. Frequency used for heavy breasts was 5MHz while for lighter breasts 9MHz. Colour gain was asjusted according to the requirement. The parameters observed for the color Doppler ultrasound imaging were lesion size, presence or absence of vascularity, comparison of lesion vascularity with normal tissue, resistance and systolic peak in vessels of the lesions. Patients with solid lesions having BIRAD 2 and above were booked for ultrasound guided FNAC and Trucut biopsy in same week. Biopsy results were compared with the results of color Doppler ultrasound. Statistical analysis of the results was performed for evaluation of the significance of color Doppler ultrasound.

## RESULTS

The 200 patients that were enrolled in this study were divided into {group A and Group B/two groups} based on the nature of the lesion and were observed under color Doppler ultrasound. Group A consisted of 86 patients who had malignant lesions and Group B has 114 patients who had benign lesions. Mean age group of the participants were 38.66 ± 10.20 and there was found no significant statistical difference between two groups in mean age.

Breast mass size and side has no relation with benign and malignancy. Mean size of tumor in width and height in malignant group was found 262.70 ± 153.74mm2 and in benign group was found 154.52 ± 71.3 mm2. Mean size of the tumor was found different in both groups.

Vascularity in the breast cancer found in benign and malignant lesions was the parameter of differentiating the lesions. From our study of 200 cases increased blood vessels observed in malignant group 96.5% and among benign group it was 37.7%

**Table 1**

| Blood vessel | Malignant Group A | Benign Group B |
|---|---|---|
| **Normal** | 3(3.5%) | 15(37.7%) |
| **Decreased** | 0 | 10(24.6%) |
| **Increased** | 83(96.5%) | 15(37.7%) |

Blood flow increases in tumors hence velocity increases and resistance reduce from tissues. Therefore, blood flow pattern, waveform, peripheral and central blood flow, resistive index and systolic peak velocity helps to differentiate malignant lesions from benign lesions. Low systolic velocity and systolic peak was found in benign lesions with reduced resistive index and same peripheral and central blood flow pattern. Statistical significance was found 0.05. It was also observed that the vascularity of benign breast lesions was less in comparison to high vascularity in malignant breast lesions.

From findings mean value of RI in malignant lesions was 0.76 ± 0.092 and in benign lesions was 0.64 ± 0.064.

**Table 2**

| Malignancy parameter | Malignant lesion | Benign Lesion |
|---|---|---|
| **Resistive Index mean** | 0.76 ± 0.092 | 0.64 ± 0.064 |
| **Systolic peak** | High | Low |


**Figure 1:** Lesion appeared ill-defined hypoechoic with RI of 0.8 on colour doppler ultrasound and was invasive ductal carcinoma on Trucut biospy in a 37 years old patient


**Figure 2:** Well, defined hypoechoic area with lobulated margins showed RI of 0.66, which turned out to be fibroadenoma on cytology in a 30 years old patient

Blood flow pattern of peripheral and central flow was different in malignant cases. Sharp systolic peak, high systolic velocity and high resistive index was found in central blood flow pattern. Waveform pattern is a strong parameter for malignant lesions.

| | Positive | Negative |
|---|---|---|
| **Biopsy** | 72 | 14 |
| **Doppler** | 11 | 103 |

Table 4

| Statistical Parameter | Values |
|---|---|
| **Positive Predictive Value** | 83.72% |
| **Negative Predictive Value** | 90.35% |
| **Sensitivity** | 86.75% |
| **Specificity** | 88.03% |
| **Diagnostic accuracy** | 87.5% |

Color Doppler ultrasound results when compared with the results of biopsy true positive cases were 72 and false positive cases were 14. False negative cases were 11 and true negative cases were 103. Positive predictive value calculated was 83.72%, negative predictive value calculated was 90.35%, sensitivity of the color Doppler ultrasound was 86.75% and specificity of color Doppler ultrasound was 88.03% Over all diagnostic accuracy of color Doppler ultrasound was 87.5%.

## DISCUSSION

Neoplasia is present in malignant breast cancer and due to metastasis, it grows and spreads to other organs. Color Doppler ultrasound is a helpful tool to diagnose type of lesions accurately. Aim of present study was to differentiate malignant lesions from benign in suspected breast cancer patients. Resistive index was main indicator to predict nature of lesions. From the results of Color and spectral Doppler ultrasound, it was observed that malignant lesions were more vascular in comparison with benign lesions. From the study 96.5% cases of the malignant lesions have blood vessels and enhanced vascularity while 37.7% of benign lesions have increased vascularity. From findings mean value of resistive index in malignant lesions was 0.76 ± 0.092 and in benign lesions was 0.64 ± 0.064. Early diagnosis has good prognosis and can reduce morbidity and mortality among women therefore awareness programs should be introduced for self-screening of breast before it gets too late.

A study conducted in our neighboring country by Reghunath, et al 2021 involving 50 patients have concluded that resistive index, pulsatility index and peak systolic velocity were main indicators in differentiating benign lesions from malignant breast lesions. Their respective mean values in benign group were RI 0.69 ± 0.19 PSV 13.71 ± 6 while among malignant group RI mean was 0.93 ± 0.12, PSV 15.57 ± 11.19.[7] Study findings are close to our study results.

Similar study was conducted by Song, X.et al, (2020) involving 103 patients found that morphology, calcification, mass boundary, internal echo, resistive index, blood flow signal and pulsatility index were the main parameters to differentiate malignant lesions from benign lesions. The mean value of RI and PI in benign group was 0.61 ± 0.03 and 1.02 ± 0.21 and in malignant group mean RI was 0.83 ± 0.05 and 1.65 ± 0.31.[8]

The difference in resistive index values of benign and malignant breast lesions was also reflected by another study by Jain S et al, 2022 that concluded that range of Resistive index in benign group was 0.56-0.80 and in malignant group was 0.65-0.92. [9]

Gupta et al, 2017 in their study involving 173 patients of breast lesions has concluded that hyper vascularity, irregular caliber and resistive index were the main indicators of malignancy. RI mean in malignant group was found was 0.80 ± 0.16 and in benign group RI mean was 0.63 ± 0.08 which is near to our RI mean (benign group 0.64 ± 0.064 and malignant group 0.76 ± 0.092). [10] Huina Zhang et al, has described in his study that vascularity is important parameter for differentiating benign from malignant breast lesions. [11] Age group has nothing to do with the breast cancer from our study. Khan NH et al, 2021 concluded that different awareness and screening programs can help to reduce the death rate among women due to cancer. [1] Parveen et al ,2020 in their studies have concluded that color Doppler ultrasound is helpful in detecting and differentiating breast malignancy among suspected breast cancer patients. Their sample size was 150 patients and have concluded that resistive index is useful parameter to detect malignancy with diagnostic accuracy of 90.7%. [12] In correspondence to the results of our study, Ye XJ, et al, Amin, Mashah et al, Schmillevitch J etl al, Cho N et al, Mehri S et al, and Berg WA et al, have concluded in their respective studies that Resistive index, peak systolic velocity and vascularity were high in malignant breast lesions in comparison to benign breast lesions. [13] [14] [15] [16] [4] [17]

## CONCLUSION

Mass screening programs are significant in early detection of breast cancer. These programs are deficient in developing countries, so color and spectral doppler ultrasound can be used in early detection of breast cancer as it is readily available in virtually all local setups. It is a safe and noninvasive imaging technique. Resistive index, systolic peak and vascularity are useful indicators for detecting malignancy.

## ETHICAL APPROVAL

Ethical approval was granted by the Ethical Review Committee of Post Graduate Medical Institute/ Ameer-ud-Din/ Lahore General Hospital, Lahore vide reference No 66/65/22 dated: 06/07/2022

## CONFLICT OF INTEREST:

Authors declare no conflict of interest.

**FUNDING SOURCE:** None

## AUTHOR'S CONTRIBUTIONS

**SRA:** Concept design, Data collection and manuscript writing
**NR:** Data analysis and manuscript writing
**AY:** Critical analysis and manuscript writing
**SA:** Interpretation & analysis of data and manuscript writing and supervision
**ALL AUTHORS:** Approval of the final version of the manuscript to be published

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