

THE CONTRIBUTION OF COLOR DOPPLER ULTRASONOGRAPHY FOR THE DIAGNOSIS OF BREAST MASSES

Original Article

RENKLİ DOPPLER ULTRASONOGRAFİNİN MEME KİTLELERİNDE TANIYA KATKISI

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INTRODUCTION

For the early diagnosis of breast cancer the selection of the proper radiological imaging modality is very crucial. Color Doppler ultrasonography (CDUS) is a non-invasive and easily applicable modality which can detect tumor neovascularization. We aimed to explore the contribution of CDUS to the other modalities for the diagnosis of breast lesions.

MATERIAL AND METHOD

71 patients having solid breast masses were evaluated by ultrasonography (US), CDUS, and mammography. Also, spectral data were examined and maximum peak systolic velocities, minimum end diastolic velocities, resistivity index (RI) values were measured and the presence of venous flows were noted. For the control values same measurements were obtained from locations other than the mass area. Histopathological diagnosis was achieved by fine needle, incisional or excisional biopsies. 49 masses were found to be malignant, 22 masses were benign.

FINDINGS

Eight of the benign lesions had venous flow pattern, others had arterial vascularity. 2 of the lesions with arterial flow pattern had central, 12 had peripheral vascularization. All had RI values less than 0.70. 2 of the 49 malignant masses had venous vascularization. 22 of the 47 masses with arterial flow had central vascularity. 8 of the malignant masses had RI values below 0.70, 39 malignant lesions had RI values greater than 0.70. Venous vascularization was found to be statistically significant, as a criteria for benignity ($p < 0.05$). Also, a

statistically significant correlation was found between histopathological diagnosis and central-peripheral vascularity patterns ($p<0.05$). In addition, higher RI values were found to be a significant criteria for malignancy ($p<0.05$).

CONCLUSION

When the modalities US, CDUS, and mammography are used together, the sensitivity for the diagnosis of breast masses was 98%, the specificity was 86%. Positive predictive value was 94% and correction rate was 94%. It was concluded that CDUS is a complementary modality for the differentiation of malignant and benign breast masses.

Key words: *Color Doppler ultrasonography; breast; mammography .*

ÖZET AMAÇ

Meme kanserinde, erken tanı ve tedavi için radyolojik yöntemlerin etkin kullanılması büyük önem taşımaktadır. Kolay uygulanabilir, non-invaziv yöntem olan renkli Doppler ultrasonografi(RDUS) - tümör neovaskülarizasyonunu saptayabilmektedir. Çalışmamızda, RDUS'nin, meme lezyonlarının tanısında diğer inceleme yöntemlerine katkısını araştırmayı amaçladık.

GEREÇ VE YÖNTEM

Memede solid kitle saptanan 71 olgu, mamografi, gri-skala ultrasonografi(US) ve RDUS ile değerlendirildi. RDUS ile kitlelerden spektral eğriler elde edilip maximum peak sistolik, minimum end diastolik hızlar, rezistivite indexi(RI) ölçüldü, venöz akımlar kaydedildi. Kontrol amacıyla karşı taraf memenin aynı bölgesindeki ve kitle dışındaki normal dokudan akım ölçümleri yapıldı. İnce iğne, insizyonel biopsi ve/veya cerrahi rezeksiyon ile histopatolojik tanıya gidildi. 49 olgu malign, 22 olgu benign histopatolojik tanı aldı.

BULGULAR

Benign lezyonların 8' inde venöz akım paterni, diğerlerinde arteriyel akım izlendi. Arteriyel akım izlenenlerin 2' sinde santral, 12'sinde periferik akım saptandı ve RI 0.70'den küçüktü. 49 malign kitlenin, 2' sinde venöz akım saptandı. Arteriyel akıma sahip olan 47 kitlenin 22' sinde santralde akım izlendi. RDUS'de malign kitlelerde RI değeri, 8 kitlede 0.70 altında, 39 kitlede 0.70 in üzerindeydi. Venöz kanlanma saptanmasının benignite lehine istatistiksel olarak anlamlı bir kriter olduğu görüldü ($p<0,05$). Periferik ve santral kanlanma paterni ile histopatolojik tanı arasında istatistiksel olarak anlamlı bir ilişki saptandı ($p<0,05$). RI değerleri histopatoloji sonuçlarıyla karşılaştırıldığında, yüksek RI'nin malignite açısından anlamlı olduğu izlendi ($p<0,05$).

SONUÇ

Meme kitlelerinin tanısında, mamografi, gri-skala US, RDUS birlikte uygulandığında sensitivite %98, spesifite %86 olarak saptandı. Pozitif öngörü değeri, bu yöntemler birlikte uygulandığında %94, doğruluk oranı %94 bulundu. Çalışmamızda, RDUS incelemenin, meme kitlelerinin malign-benign ayrımında tamamlayıcı bir değere sahip olduğu sonucuna varıldı.

Anahtar Sözcükler: *Renkli Doppler ultrasonografi; meme; mamografi.*

INTRODUCTION

Breast cancer is the most common malignancy in women with a high mortality rate (1, 2). The correct use of radiological methods is important for early diagnosis. Ultrasound and mammography are the most commonly used modalities for diagnostic purposes. Recently, magnetic resonance imaging has been used more frequently as an adjuvant diagnostic method. Color Doppler ultrasonography (CDU) is another modality used for diagnosis, due to its ability to detect tumoral

neovascularization (1-7). There are many studies reporting different results about the contribution of CDU in terms of differentiation and diagnosis of benign and malignant lesions of the breast (8-11). In our study, we have investigated the contribution of CDU for the differentiation of benign and malignant breast lesions.

MATERIALS AND METHODS

A total of 71 cases, which were referred to Izmir Atatürk Training and Research Hospital, Department of Radiology, with a pre-diagnosis of solid breast mass according to mammography and gray-scale ultrasonography (US) findings were included in the study. The age distribution of patients was 26 to 75 years, with a mean age of 47 years. In all cases, mammography and gray-scale US were performed prior to CDU.

In the mammographic examination, the standard craniocaudal and mediolateral oblique positions, and when necessary, focal compression and/or magnification radiographs were obtained. Both breasts were then evaluated using the real-time B-mode ultrasound and the color Doppler imaging methods. US and CDU examinations were performed with an 8 MHz linear transducer.

Spectral curves were obtained from the vascular structures observed in the center, or the periphery of the mass lesions. The maximum peak systolic velocity, the end diastolic velocity, and the minimum resistivity index (RI) were measured by means of the spectral curves. The available venous flows were also recorded. For comparison, the assessment of vascularity and flow measurements were performed in the contralateral normal appearing breast tissue.

In all patients, histopathological diagnosis was made by means of fine-needle biopsy, incisional biopsy and/or surgical resection.

The sensitivity and specificity values of the results were calculated statistically.

RESULTS

The distribution of 71 cases with solid breast masses, according to the histopathological results is shown in **Table 1**.

	N	%
<u>Invasive ductal carcinoma</u>	25	35,21
<u>Fibroadenoma</u>	11	15,49
<u>Ductal carcinoma</u>	6	8,45
<u>Fibrocystic disease</u>	3	4,23
<u>Lobular carcinoma</u>	3	4,23
<u>Mixed breast carcinoma</u>	3	4,23
<u>Mucinous carcinoma</u>	3	4,23
<u>Complicated cyst</u>	2	2,82
<u>Fat necrosis</u>	2	2,82
<u>Miscellaneous (atypical ductal hyperplasia, atypical lipoma, B cell lymphoma, inflammation, intracystic papiller ca, invasive lobular carcinoma, simple cyst, comedo ca, lymphoma, schwannoma)</u>	13	18,31
Total	71	100,00

Table.1: The pathologic distribution of the breast lesions.

Fortynine of the 71 cases were histopathologically malignant (25 of which were invasive ductal carcinoma), whereas 22 were benign. Fibroadenomas accounted for half of the histopathologically benign lesions.

In the mammographic evaluation, the well-defined lesions that were of low-density, microcalcification-free, and did not cause skin retraction were considered to be benign.

In the gray-scale ultrasonography, smooth lesions with rounded contour and homogeneous internal echo, and those that did not have retrotumoral acoustic shadowing appearance were considered as benign.

Of the benign lesions, eight had a venous flow pattern, while arterial flow

was observed in the remaining. In the latter, two patients had a flow in the center of the mass, while the others had a peripheral flow.

Of the 49 malignant masses, only two had venous flow. Of the 45 masses with arterial flow, 22 had a flow in the center of the mass. The RI value obtained by CDU was found to be below 0.70 in eight cases. Venous flow was observed in two masses. The RI value was above 0.70 in 39 masses.

The validity of mammography, gray-scale ultrasound, and color Doppler ultrasound in differentiating malignant and benign breast lesions and the combined validity of the three methods are summarized in **Table 2**.

DIAGNOSTIC TEST	MAMMOGRAPHY(MG)	GRAY-SCALE ULTRASOUND (GSU)	COLOR DOPPLER ULTRASOUND (RDU)	COMBINED MG+GSU+RDU
SENSITIVITY	94%	92%	82%	98%
SPECIFICITY	38%	73%	64%	86%
POSITIVE PREDICTIVE VALUE	86%	88%	83%	94%
NEGATIVE PREDICTIVE VALUE	60%	80%	61%	95%
ACCURACY RATE	83%	86%	76%	94%

Table 2: The validity of mammography, gray-scale ultrasound, and color Doppler ultrasound in differentiating malignant and benign breast lesions and the combined validity of the three methods.

Figure 1 presents the ultrasonography findings of a case diagnosed with invasive ductal carcinoma.

Figure 1

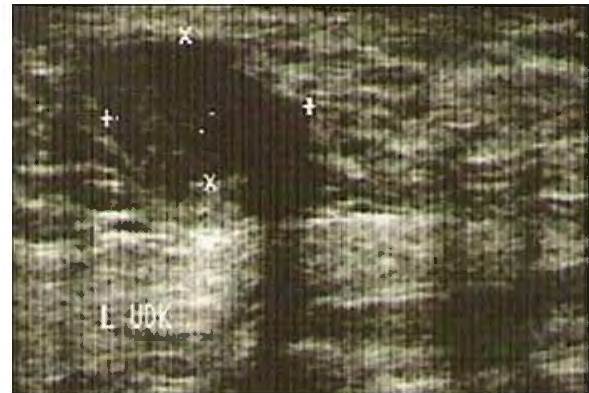


Figure 1: In the gray-scale ultrasonography, a hypoechoic lesion with a lobulated contour and acoustic shadow

Figure 2 shows the craniocaudal and mediolateral mammograms of the left breast, a mass with a speculated contour in the lower middle quadrant, with a diameter of 3 cm. At **Figure 3**, doppler ultrasonography revealed an intense internal arterial vascularity with a Vmax: 12.6 cm / sec, Vmin: 2.2cm / sec, and RI: 0.83 in the lesion samples, which were consistent with malignancy.

Figure 2



Figure 2: In the craniocaudal (CC) mammography of the left breast, in the lower-middle quadrant, an opaque lesion of 32x20 mm with a speculated contour was observed.

Figure 3

Figure 3: Doppler examination of the lesion presented in Figure 2, Vmax: 12.6 cm / sec, Vmin: 2.2cm/sec, RI: 0.83. The current sample was considered compatible with malignancy. Pathologic diagnosis was invasive ductal carcinoma.

The pathologic diagnosis was invasive ductal carcinoma. In **Figure 4**

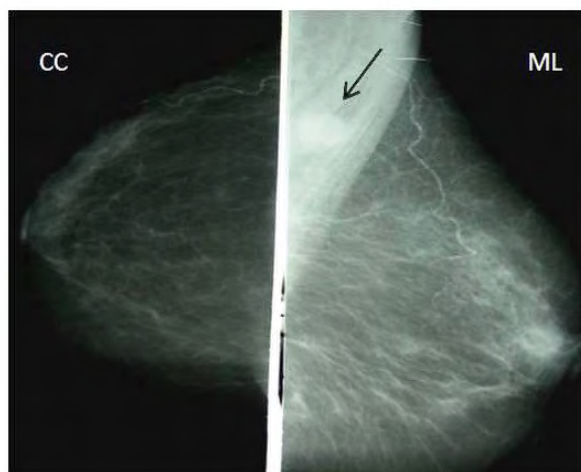


Figure 4: In the craniocaudal (CC) and mediolateral (ML) radiographs of the right breast in the ML mammography, a well-demarcated opaque lesion with a diameter of 20x15 mm was observed on the right axillary tail (black arrow).

a well-demarcated opaque lesion with a diameter of 20x15 mm is observed on the right axillary tail (black arrow). In **Figure 5,**

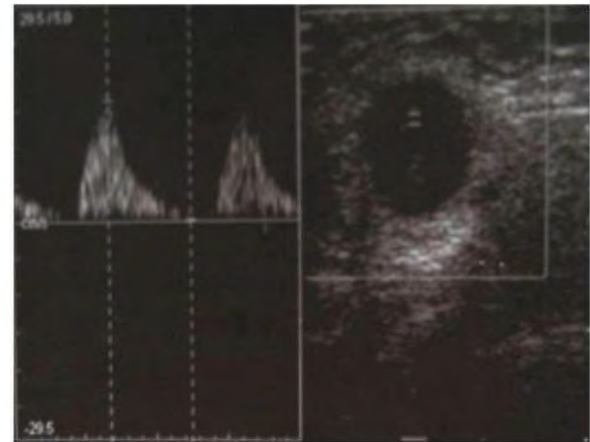


Figure 5: Doppler examination of the lesion is presented in Figure 4, with Vmax: 16.3 cm / sec, Vmin: 3.3 cm / sec, RI: 0.99 cm / sec, respectively. Pathological diagnosis: schwannoma.

in the doppler ultrasonography examination of the lesion presented in Figure 4, the internal arterial codes were determined. The values of the lesion samples were as follows: Vmax: 16.3 cm / sec, Vmin: 3.3 cm / sec, RI: 0.99 cm / sec, respectively. The lesion, which was thought to be malignant, had a pathological diagnosis of schwannoma.

In the color Doppler ultrasonography, the patients with an arterial blood flow pattern were found to have higher rates of malignancy. There was a statistically significant difference between the malignant and the benign lesions with respect to the presence of arterial or venous blood flow patterns ($P < 0.05$). In the CDU, there was also a statistically significant difference with respect to the localization of the blood flow, which was classified as peripheral and central ($P < 0.05$). When the RI values in the CDU

were compared with the histopathological results, an RI value above 0.70 was found to support malignancy. The difference between groups was statistically significant ($P < 0.05$).

DISCUSSION

Nowadays, mammography and conventional ultrasonography are often used in the radiologic evaluation of breast mass lesions. Mammography is the oldest and still the most reliable imaging modality used in diagnosis of the diseases of the breast (1-3). As a result of studies in mass screening, it has been shown that tumors too small (occult) to be noticed during physical examination could be shown with mammography. In this way, one is able to resume the adequate treatment in the early stages of cancer. The new high-resolution mammography and conventional ultrasound devices are very effective methods in discriminating the benign and malignant lesions of the breast (2-8).

In 1977, Wells et al. (12) evaluated breast lumps and malignant breast masses with color wave Doppler for the first time, and reported that they have recorded strong Doppler signals. In 1982, in their study including 55 malignant breast masses, Burns et al. (6) evaluated the differences between the measurements done with color wave Doppler of malignant masses in the same locations on contralateral breast. In this study, peak systolic, end diastolic, and mean frequency differences were found to be statistically significant.

With color Doppler ultrasonography, the vessels located in the periphery of the mass, which extend centrally, can be displayed and a spectrum analysis can be done. Another finding, which is quite effective in evaluating the tumor in the color Doppler examination, is the signal type. The most common type of tumor Doppler signal was defined by Wells et al. in 1977 for the first time (12), and has been confirmed by various studies. This

type of signal is a Doppler shift of high peak systolic frequency with or without a significant diastolic flow. In our series, we have recorded significant flow samples both in the peripheral parts of the tumor, as well as centrally. In benign solid masses, the peripheral venous flow samples were particularly present. However, in the malignant masses, mostly arterial flow was detected.

CDU has been used more frequently, since the first studies in 1977, in the diagnosis of the breast lumps(12-17). The purpose CDU examination in breast masses is to display the vessels of the mass lesions and to make the benign/malignant differentiation by measuring the flow values in the veins and the arteries. Various results have been reported about the contribution of contrast agent administration in the CDU and power Doppler (PW) imaging studies (10, 16). However, the echo contrast agents are not widely used.

In the first studies with Power Doppler (PW), it has been reported that some of the recorded flows were one-way, whereas some were two-way. Schoenberger et al. (7) reported six one-way signals and four two-way, and particularly symmetrical signals. In our series, all samples had one-way flow. This is likely due to the 'mirror image', which emerges as a result of deterioration of the discrimination property of the PW devices between the antegrade and the retrograde flows, when the angle between the transducer and the vessel flow direction is close to 90 degrees. Therefore, we believe that the flow directions are not significant in the evaluation.

After various studies in breast imaging, color Doppler ultrasonography has been used in different fields. The color Doppler samplings of the lateral thoracic artery have been reported to be useful in preoperative prediction of the malignant lesions and guiding the operation (18). More recently, the use of color Doppler ultrasonography as an imaging method

following mastectomy, chemotherapy, and radiotherapy as a follow-up modality for the recurrent and the residual disease has been subject to discussion (19).

In this study, it was concluded that the color Doppler examination has a complementary contribution to mammography and ultrasonography. In summary, this study showed that in mass lesions, the detection of venous flow pattern is evidence in favor of benignity, whereas for masses with arterial flow curves, high RI (RI above 0.70) values of the spectral curves were in favor of malignancy.

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