Accuracy of sonographic findings in breast cancer: correlation between BI-RADS® categories and histological findings*

Acurácia dos achados ultrassonográficos do câncer de mama: correlação da classificação BI-RADS® e achados histológicos

José Hermes Ribas do Nascimento[1], Vinicius Duval da Silva[2], Antonio Carlos Maciel[3]

Abstract **OBJECTIVE: The main purpose of the present study is to evaluate the accuracy of ultrasonography (BI-RADS) in the diagnosis of breast cancer whereas the additional specific objectives are to describe the frequency of different sonographic findings and evaluating interobserver agreement. MATERIALS AND METHODS: Images of 110 patients who had been referred for biopsy with previous diagnosis of breast nodules were independently reviewed by two specialists according to the BI-RADS classification. Histological findings were utilized as a gold-standard. The accuracy of findings was determined. The chi-squared test for categorical variables was utilized in the analysis of the differences resulting from the groups comparison, and the interobserver agreement was calculated with kappa (κ) statistics. RESULTS: Among 110 breast masses evaluated by ultrasonography, 76 (69%) were benign and 34 (30.9%) were malignant. According to the radiologists, the sensitivity ranged from 70.5% to 82.3%, negative predictive value, from 81.1% to 87.5%, positive predictive value, from 42.1% to 45.1%, specificity from 56.58% to 55.2%, and accuracy from 60.9% to 63.6%. The global interobserver agreement was considered as moderate (κ = 0.50). CONCLUSION: The fourth edition of BI-RADS provides radiologists with an accurate clinical decision support system for the diagnosis and management of breast disease.**
Keywords: Breast cancer; Ultrasonography; BI-RADS; Anatomopathological; Accuracy.

Resumo **OBJETIVO: O objetivo geral do estudo é avaliar a acurácia da ultrassonografia (BI-RADS) no diagnóstico do câncer de mama, e os objetivos específicos, descrever a frequência de apresentação dos diferentes achados ultrassonográficos e a avaliação da concordância entre observadores. MATERIAIS E MÉTODOS: Exames de 110 pacientes encaminhados para biópsia, com diagnóstico prévio de nódulos, foram reanalisados independentemente por dois médicos especialistas utilizando a nomenclatura do BI-RADS. Os achados histológicos foram utilizados como padrão-ouro. A acurácia dos achados foi determinada. As diferenças nos grupos de comparação foram analisadas com teste qui-quadrado para variáveis categóricas e a concordância entre os médicos foi calculada por meio da estatística kappa (κ). RESULTADOS: Cento e dez massas mamárias foram avaliadas pelo ultrassom, sendo que 76 (69%) foram benignas e 34 (30,9%), malignas. Foram observados, entre os radiologistas, sensibilidade variando entre 70,5% e 82,3%, valor preditivo negativo entre 81,1% e 87,5%, valor preditivo positivo entre 42,1% e 45,1%, especificidade entre 56,58% e 55,2% e acurácia entre 60,9% e 63,6%. Na avaliação entre observadores foi obtida concordância global considerada moderada (κ = 0,50). CONCLUSÃO: O BI-RADS 4ª edição é um acurado sistema para auxiliar os médicos na descrição das lesões mamárias e na tomada de condutas.**
Unitermos: Câncer de mama; Ultrassonografia; BI-RADS; Anatomopatológico; Acurácia.

Nascimento JHR, Silva VD, Maciel AC. Accuracy of sonographic findings in breast cancer: correlation between BI-RADS® categories and histological findings. Radiol Bras. 2009;42(4):235–240.

INTRODUCTION

Ultrasonography as an adjuvant to clinical examination and mammography is considered as the most effective method for the diagnosis of breast lesions[(1)]. This is due to the technological development of ultrasonography devices such as real-time transducers with high digital frequency of 7.5 MHz, 10 MHz and 13 MHz, and harmonic imaging. These multi-frequency transducers provide high-resolution images, depth penetration and a high number of scanning lines[(2,3)].

Although breast ultrasonography has been historically utilized for differentiating solid from liquid lesions, there is an increasing interest in the utilization of this method for differentiating malignant from benign masses. Additionally, ultrasonography has become a valuable tool in the characterization of nodules found at mammog-

* Study developed at Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, RS, Brazil.

1. Master, MD, Radiologist, Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, RS, Brazil.

2. PhD, MD, Pathologist, Associate ProfessorProfessor, Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, RS, Brazil.

3. Head for the Unit of Radiology – Santa Casa de Misericórdia de Porto Alegre, MD, Radiologist – Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil.

Mailing address: Dr. José Hermes Ribas do Nascimento. Rua Marechal Floriano, 774, Meller Sul. Santo Ângelo, RS, Brazil, 98801-650. E-mail: josehermesribas@hotmail.com

Received December 27, 2008. Accepted after revision April 22, 2009.

raphy, thus avoiding unnecessary biopsies and eliminating the necessity of follow-up mammography[4–6]. The breast ultrasonography sensitivity has been reported as superior to that of mammography[7,8] in premenopausal women and, recently, sonographic screening has also been recommended for evaluation of dense breasts[9]. Studies have demonstrated the usefulness of ultrasonography for detection of clinically and mammographically occult, nonpalpable breast carcinomas[10,11].

The Breast Imaging Reporting and Data System (BI-RADS®) lexicon for ultrasonography was developed by the American College of Radiology (ACR) aiming at increasing the clinical efficacy of the method and at standardizing the reports organization and wording. There is a specific vocabulary for describing each lesion, and, at the end of the report, the lesion is classified into categories ranging from 0 to 6 according to the findings suspicion degree based on the positive predictive value (PPV) of the study for breast cancer[12–14].

The BI-RADS lexicon includes a sonographic description of breast nodules or masses considering contours, orientation, margins, lesions limits, internal echoes pattern, characterization of posterior acoustic shadowing, borders and abnormalities in adjacent tissues. At the end of the description, the lesion is assigned to a BI-RADS category[13,15].

The present study primarily proposes an evaluation of the sonographic BI-RADS classification accuracy for differentiating benign lesions from malignant masses. The secondary objectives were the description of the frequency of different sonographic findings and the evaluation of the interobserver agreement.

MATERIALS AND METHODS

Two physicians specialized in breast imaging diagnosis independently reviewed studies of 110 patients referred to a clinic in the Northwestern region of the Rio Grande do Sul state (Brazil) for core biopsy. Previously, all of them had been sonographically diagnosed with breast nodules or masses classified into BI-RADS categories 3, 4 or 5. Each specialist, with more than ten years of professional experience, course of residency in radiology, specialist title and/or course of specialization in mammography by Colégio Brasileiro de Radiologia e Diagnóstico por Imagem (CBR), blindly reviewed the sonographic studies, utilizing the BI-RADS terminology, evaluation and recommendations included in the most recent lexicon for echography. Later, the reviewed studies were compared with the anatomopathological results.

The ultrasonography studies were performed with a high-resolution Sonoline G50 (Siemens Medical Solutions; Berlin, Germany) equipment with 7.5 MHz and 10 MHz linear array transducers.

The accuracy of the BI-RADS classification in ultrasonography was evaluated by calculating sensitivity, specificity, PPV and negative predictive value (NPV) for each of the described characteristics, and in the differentiation between benign and malignant lesions. Histological findings were utilized as standard criteria.

The interobserver agreement for the final categories and separately for each category was analyzed by the kappa test (κ) and the differences between groups were analyzed through the chi-square test for categorical variables.

The BI-RADS lexicon for ultrasonography considers the following terms for describing breast nodules: shape, margins, orientation of the nodule in relation to the skin axis, lesion borders, internal echoes pattern, posterior acoustic characteristics and alterations in adjacent tissues.

After their description in compliance with the BI-RADS criteria, all the lesions were classified into categories 3, 4 or 5 (Chart 1).

Category 3 included the well-defined lesions, ovoid or rounded in shape (contour), with a parallel orientation in relation to the skin axis, circumscribed margins, absent posterior acoustic shadowing or presence of posterior acoustic enhancement, and absence of alterations in adjacent tissues. Lesions associating at least three signs of malignancy were classified into BI-RADS category 5 including irregular contour, nonparallel orientation in relation to the skin axis, noncircumscribed margins, presence of hyperechogenic halo, posterior acoustic shadowing and alteration in the adjacent tissues.

BI-RADS category 4 included the lesions that did not met the benignity criteria neither combined three signs of malignancy, so being classified as indeterminate.

The patient's age, the site and size of the lesion were also taken into consideration. Histological findings were compared with sonographic characteristics.

BI-RADS lexicon diagnostic accuracy, sensitivity, specificity, PPV and NPV for ultrasonography were calculated, including category 3 in the benign group, and unifying categories 4 (probably benign) and 5 in the malignant lesions group. VPPs and NPVs for each category and description were obtained.

RESULTS

The present study included 110 breast nodules, 108 in female patients and 2 in male patients. All the lesions were assessed by ultrasonography and later submitted to histological study. The patients' mean age was 49.67 ± 12.09 years.

Based on the sonographic BI-RADS classification, the lesions were distributed as follows: observer A – 53 (48.18%) category 3, 39 (35.46%) category 4, and 18 (16.4%) category 5; observer B – 48

Chart 1 Final clinical conduct according to BI-RADS classification[12].

Incomplete evaluation
Category 0 (zero): requires additional imaging evaluation
Complete evaluation
Category 1: negative
Category 2: negative findings
Category 3: probably benign findings – suggesting short interval follow-up
Category 4: suggestive of abnormality – biopsy should be considered (indeterminate)
Category 5: highly suggestive of malignancy – an appropriate conduct should be adopted
Category 6: biopsy-proved malignant disease

(43.64%) category 3, 44 (40%) category 4 and 18 (16.4%) category 5. No lesion was classified as categories 0, 1, 2 and 6.

Amongst all the cases included in the present study, 76 (69%) were benign, and 34 were malignant at the anatomopathological study.

According to the observer A, NPV was 81.1%, PPV, 42.10%, sensitivity, 70.0%, specificity, 56.5%, and accuracy, 60.9%.

On the other hand, according to the observer B, NPV was 87.5%, PPV, 46.6%, sensitivity, 82%, specificity, 55.2% and accuracy, 63.6% (Tables 1 and 2).

Table 1 Distribution of false- and true-positive results and false- and true-negative results based on pathological and discriminate diagnoses – observer A.

Test result	Positive disease n	(%)	Negative disease n	(%)	Total n	(%)
T+ (category 4, 5)	24	(42.11) TP	33	(57.89) FP	57	(100)
T– (category3)	10	(18.87) FN	43	(81.13) TN	53	(100)
Total	34	(30.9)	76	(69.1)	110	(100)

Parameters	Formula	%
Sensitivity	TP/(TP + FN)	70.59 (with disease and positive test)
Specificity	TN/(TN + FP)	56.58 (without disease and negative test)
Positive predictive value	TP/(TP + FP)	42.1
Negative predictive value	TN/(TN + FN)	81.1
Accuracy	(TP + TN)/Total	60.9

T+, positive test (lesion rated as category 4 or 5); T–, negative test (lesion rated as category 3); TP, true-positive; FP, false-positive; TN, true-negative; FN, false-negative.

Table 2 Distribution of false- and true-positive results and false- and true-negative results based on pathological and discriminate diagnoses – observer B.

Test result	Positive disease n	(%)	Negative disease n	(%)	Total n	(%)
T+ (category 4, 5)	28	(45.16) TP	34	(54.84) FP	62	(100)
T– (category 3)	6	(12.5) FN	42	(87.5) TN	48	(100)
Total	34	(30.9)	76	(69.1)	110	(100)

Parameters	Formula	%
Sensitivity	TP/(TP + FN)	82.3 (with disease and positive test)
Specificity	TN/(TN + FP)	55.2 (without disease and negative test)
Positive predictive value	TP/(TP + FP)	45.1
Negative predictive value	TN/(TN + FN)	87.5
Accuracy	(TP + TN)/Total	63.6

T+, positive test (lesion rated as category 4 or 5); T–, negative test (lesion rated as category 3); TP, true-positive; FP, false-positive; TN, true-negative; FN, false-negative.

Sonographic nodules characteristics

Sonographically, the nodules demonstrated the following morphological characteristics: lesions contour, margins, internal echoes pattern, orientation in relation to the skin axis, posterior acoustic characteristics, borders and alterations in adjacent tissues[14].

a) *Evaluation of the lesions shape*

According to the observer A, the lesions were round-shaped in 71 cases, ovoid in 13 cases, and irregular in 25 cases. Among the 71 round-shaped lesions, 83.1% were benign, and 16.9% malignant. Among the irregular nodules, 21 were malignant, and four were benign for a PPV de 84%. The NPV for ovoid lesions was 42.9%,and for round-shaped lesions, 83.1%.

According to the observer B, round-shaped was described in 67 masses, ovoid in 22, and irregular in 21. Among the 67 rounded-shaped lesions, 76.1% were benign and 23.9%, malignant. The NPV for rounded-shaped lesions was 76.1%, and 77.3% for ovoid lesions. Among the irregular lesions, 14 were malignant for a PPV of 65%.

b) *Evaluation of the lesions margins*

According to the observer A, the margins were circumscribed in 68 cases, and noncircumscribed in 42. Only 12 (17.6%) of the 68 lesions with circumscribed margins were malignant. Only four (6%) among the cases with circumscribed margins were classified in category 5 (Table 3).

Out of 42 masses, 22 with noncircumscribed margins were malignant. The PPV for noncircumscribed margins was of 52.4%, and the NPV for circumscribed margins was of 82.4%. Sensitivity was 64.7%, and specificity, 73.7%.

According to the observer B, margins were circumscribed in 61 cases and noncircumscribed in 49. Only 12 (19.7%) of the 61 lesions with circumscribed were malignant. Only three cases (4.9%) with circumscribed margins were classified as category 5 (Table 4).

It was observed that 22 of 49 cases with noncircumscribed margins were considered as malignant. The PPV for noncircumscribed margins was of 44.9%, and the

Table 3 Distribution of margins and relationship with the BI-RADS classification for ultrasonography – observer A.

Distribution	Category 3 Benign	Category 3 Malignant	Category 4 Benign	Category 4 Malignant	Category 5 Benign	Category 5 Malignant	Total Benign	Total Malignant	Total
Circumscribed — *n* (%)	37 (84.1)	7 (15.9)	17 (85.0)	3 (15.0)	2 (50.0)	2 (50.0)	56 (82.4)	12 (17.6)	68
Noncircumscribed — *n* (%)	6 (66.7)	3 (33.3)	12 (63.2)	7 (36.8)	2 (14.3)	12 (85.7)	20 (47.6)	22 (52.4)	42
Total	43	10	29	10	4	14	76	34	110

Table 4 Distribution of margins and relationship with the BI-RADS classification for ultrasonography – observer B.

Distribution	Category 3		Category 4		Category 5		Total		
	Benign	Malignant	Benign	Malignant	Benign	Malignant	Benign	Malignant	Total
Circumscribed — *n* (%)	34 (87.2)	5 (12.8)	14 (73.7)	5 (26.3)	1 (33.3)	2 (66.7)	49 (80.3)	12 (19.7)	61
Noncircumscribed — *n* (%)	8 (88.9)	1 (11.1)	17 (68.0)	8 (32.0)	2 (13.3)	13 (86.7)	27 (55.1)	22 (44.9)	49
Total	42	6	31	13	3	15	76	34	110

NPV for circumscribed margins was of 80.3%. Sensitivity was 64.7%, and specificity, 64.5%.

c) *Evaluation of internal echoes patterns*

Internal echoes patterns were observed as follows: hypoechoic in 85 cases, isoechoic in two, hyperechoic in two, and complex in 14 cases. All the hyperechoic lesions were benign, and 71.4% of lesions with complex pattern were benign. Among the 85 (77.3%) hypoechoic nodules, 26 were malignant, with PPV of 30.6%.

According to the observer B, the internal echoes pattern were hypoechoic in 79 cases, isoechoic in two, hyperechoic in five, and complex in 17 cases. Particularly, the complex pattern represented 15 (92.8%) of the nodules classified as categories 4 and 5. All the hyperechoic lesions were benign, and 58.8% of lesions with complex pattern were benign. Among the 79 (71.8%) hypoechoic nodules, 22 were malignant, with PPV of 27.8%.

d) *Evaluation of nodule orientation in relation to the skin axis*

For both observers, the mean size of the lesions parallel to the skin axis was 14.2 ± 9.9 mm, and 9.4 ± 4.5 mm in the lesions with vertical orientation, with prevalence in the upper breast quadrants.

Parallel orientation in relation to the skin axis was present in 101 cases (28 malignant, and 73 benign lesions) for a NPV of 72.3%. Antiparallel orientation was present in seven cases (four malignant and three benign lesions) for a PPV of 72.3%.

e) *Description of the posterior acoustic characteristic*

According to the observer A, the absence of posterior acoustic characteristic presented a NPV of 46.7%. Out of the 110 lesions, 49 presented posterior acoustic enhancement and, among them, 40 were benign, with NPV of 81.6%; and posterior acoustic shadowing was described in 13 cases, of which two were malignant, with PPV of 15%.

According the observer B, the absence of posterior acoustic characteristic presented a NPV of 58.6%. Out of the 110 lesions, 34 presented posterior acoustic enhancement and, among them, 29 were benign, with NPV of 85.3%; and posterior acoustic shadowing was described in 11 cases, of which four were malignant, with PPV of 36.4%.

f) *Description of lesions borders*

According to the observer A, 38 (34.5%) of 110 cases presented abrupt interface and 65 (59.0%) demonstrated echogenic halo. Echogenic halo was described in 27 cases classified as category 3, with NPV of 72.3%. Abrupt interface presented NPV of 68.4%.

According to the observer B, 31 (28.1%) of cases presented abrupt interface, and 66 (60%) of the 110 cases demonstrated echogenic halo. Echogenic halo was described in 24 cases classified as category 3, with NPV of 72.1%. Abrupt interface presented NPV of 61.2%.

g) *Adjacent tissues appearance*

According the observer A, 96 of the 110 described masses did not present alteration in adjacent tissues and, among them 52 were classified as category 3, with NPV of 76.6%.

Out of 24 malignant lesions, 11 (45%) presented alteration in adjacent tissues, with PPV of 45%. Skin thickening was not observed in any case.

According the observer B, 96 of the 110 described masses did not present alteration in adjacent tissues and, among them 45 were classified as category 3, with NPV of 72.6%.

Out of 34 malignant lesions, 26 (76%) presented alteration in adjacent tissues, with PPV of 76%. Skin thickening was not observed in any case.

h) *Interobserver agreement* (Table 5)

As far as the sonographic description is concerned, a moderate interobserver agreement was observed in the evaluation of nodules orientation (κ = 0.52), that was described as parallel or antiparallel in relation to the skin axis.

A moderate agreement was observed in the evaluation of the lesions contour (κ = 0.50). Low interobserver agreement (κ = 0.29) was observed in the evaluation of the lesion borders.

Moderate agreement was also observed in the evaluation of the lesion margins (κ = 0.53) and in the description of internal echoes pattern (κ = 0.56).

The different terms utilized for describing posterior acoustic characteristic has also determined a moderate interobserver agreement (κ = 0.51).

A moderate interobserver agreement (κ = 0.51) was also observed in the evaluation of adjacent tissues, especially in cases where no alteration was found.

The κ value, for unified categories 4 and 5 was 0.36. The prevalence of breast cancer in the present study was of 34 (30.9%).

DISCUSSION

The BI-RADS classification for mammography was the first attempt to standard-

Table 5 Interobserver variability in the description of sonographic lesions.

Masses description	κ values
Lesions contour	0.50
Lesions margins	0.53
Internal echoes pattern	0.56
Lesions borders	0.29
Orientation in relation to the skin axis	0.52
Posterior acoustic pattern	0.51
Adjacent tissues appearance	0.51
BI-RADS	0.40

ize imaging findings in descriptive terms, constituting an important tool for aiding physicians both in the suspicion of malignancy and in the decision making about the strategy to be adopted[16–18]. In 2003, the BI-RADS lexicon was updated, with a refinement in the description of microcalcifications and the inclusion of topics regarding breast ultrasonography and magnetic resonance imaging.

Because of the frequency of overlapping between radiological and echographic findings and the great PPV variability among BI-RADS categories 3, 4 and 5 in mammography[18], breast lesions indicative of malignancy detected at mammography and ultrasonography have been evaluated by biopsy to prove their malignancy or benignity[4,8,19]. A high number of biopsies is performed for benign lesions because of several factors; among them the patients' dread; physicians' uncertainty or even the standard protocols utilized[1,20].

Ultrasonography should not be utilized only for differentiating cystic from solid nodules and in the evaluation of dense breasts. This method must be exploited with an accurate interpretation of the characteristics of each suspicious lesion in order to reduce the number of biopsies in benign lesions[21].

Improvements in the sonographic diagnosis have been achieved with the introduction by the American College of Radiology, of the BI-RADS classification to aid radiologists in the description of sonographic findings and that define the final classification into categories associated with a better clinical management of the cases[12].

In the present study, both observers found a sensitivity ranging between 70% and 80% (identification of malignant lesions patients with breast cancer) and high NPV, between 81% and 87% (identification of negative findings in cancer-free patients), in relation to characteristics described in the BI-RADS with 18% FN. However, BI-RADS presented a low specificity, between 55% and 56% (cancer-free patients with negative studies) because of the high number of false-positive findings. The PPV (number of cancers for sonographic characteristics) ranged between 45.1% and 42.1%.

In the present study, the sonographic accuracy ranged from 60.9% to 63.6% in the differentiation between benign and malignant lesions with the utilization of the BI-RADS. The NPV for the category 3 ranged from 81.1% to 87.5% between the observers, with a PPV ranging between 42.1% and 45.1%, similarly to the studies developed by Costantini et al.[15] and Roveda Jr et al.[20], who have demonstrated a NPV ranging between, respectively, 92.3% and 70.58% for category 3.

Thus, the utilization of the category 3, as probably benign, is a tool utilized by radiologists to avoid unnecessary biopsies, considering that the risk for malignancy of lesions described in this category corresponds to less than 2%[12]. If an increase in the lesions dimensions were observed in the follow-up, there would be a trend towards changing to BI-RADS category 4, so that the biopsy could be appropriate.

The classification of breast nodules into category 4 presents the same clinical impact and meaning as those described for category 5, since in both cases biopsy would be indicated. In the present study, the PPV for categories 4 and 5 was o, respectively, 45.2% and 42.2%, similarly to the study developed by Roveda Jr et al.[20], with a 50% PPV in category 4.

The analysis of the sonographic characteristics associated with the classification into categories 4 and 5 demonstrated that lesions with proved malignancy were frequently associated with hypoechogenicity, irregular contours, noncircumscribed margins, and antiparallel orientation in relation to the skin axis, although many of the benign nodules classified as BI-RADS categories 4 and 5 were hypoechoic, even being associated with circumscribed margins and parallel orientation in relation to the skin axis.

It could be observed that with the presence of three of the following findings, such as posterior acoustic shadowing, irregular contours, noncircumscribed margins, hypoechoic halo and antiparallel orientation in relation to the skin axis, the lesions were normally classified into categories 4 and 5, in accordance with the findings described by Chen et al.[22].

Masses demonstrating more than three characteristics suggestive of malignancy were classified into category 5 by both observers.

Nodule margins represented a relevant criterion in the differentiation between benign and malignant lesions, with a NPV ranging between 82.4% and 80.3% for circumscribed margins, not very different from the findings reported by Calas et al.[23], who had observed a NPV of 97% for circumscribed lesions. In the present study, the PPV for noncircumscribed margins ranged between 52.4% and 44.9%, differently from the NPV described by Calas et al.[23], corresponding to 70.4%.

Rounded contour (shape) was associated with high NPV that ranged between 83.3% and 76.1%; and irregular contour, with high PPV, that ranged between 84% and 65% for both observers.

Hypoechoic halo demonstrated a lower PPV than irregular contour and noncircumscribed margins. Echogenic halo presented a NPV ranging between 72.3% and 72.1%, and abrupt interface presented a NPV ranging from 68.4% to 61.2% between the observers.

Antiparallel nodule orientation in relation to the skin axis presented a high PPV (72.3%). In the study developed by Calas et al.[23] a PPV of 57.6% has been observed.

The posterior acoustic characteristic is a result of the sound attenuation. The posterior acoustic enhancement presents a NPV between 81% and 85%, for both observers. Posterior acoustic shadowing presented a low PPV, ranging between 15% and 35% in the BI-RADS categories 4 and 5. Although posterior acoustic shadowing is a sonographic characteristic of malignant lesions[15], this finding was not confirmed in the present study, being also observed in benign lesions. Fine bilateral shadowing was considered as a sign of benign lesion.

In the analysis of the interobserver variability, a moderate agreement was observed for the evaluation of the lesions orientation in relation to the skin axis ($\kappa = 0.52$), evaluation of contours ($\kappa = 0.50$), margins ($\kappa = 0.53$), posterior acoustic characteristic ($\kappa = 0.51$), internal echoes pattern ($\kappa = 0.56$) and evaluation of adjacent tissues ($\kappa = 0.51$); and low interobserver agreement was obtained for the evaluation of the lesions borders ($\kappa = 0.29$) (Table 5).

CONCLUSION

The sonographic evaluation of breasts utilizing the BI-RADS classification is an accurate method, with the interobserver variability ranging between 60.9% and 63.3% in the differentiation of malignant from benign lesions. The most frequent sonographic findings of neoplasms were irregular nodules with noncircumscribed margins and antiparallel orientation. In the present study, complex or hypoechoic internal echoes pattern, the hypoechoic borders of the lesions, and posterior acoustic shadowing presented low PPV. The overall interobserver variability was moderate.

It is believed that the practice, the systematic follow-up periods, the double-reading technique, and BI-RADS training courses for physicians should be implemented to improve even more the accuracy in the diagnosis of breast diseases, thus reducing the number of unnecessary and expensive invasive procedures.

REFERENCES

1. Chala LF, Barros N. Avaliação das mamas com métodos de imagem [editorial]. Radiol Bras. 2007;40(1):iv–vi.
2. Guiseppetti GM, Giuliani F, Baldassarre S, et al. Metodologia e semiologia. In: Veronesi U, editor. Mastologia oncológica. Rio de Janeiro: Medsi; 2002. p. 95–106.
3. Baker JA, Soo MS. Breast US: assessment of technical quality and image interpretation. Radiology. 2002;223:229–38.
4. Parker SH, Stavros AT, Dennis MA. Needle biopsy techniques. Radiol Clin North Am. 1995;33: 1171–86.
5. Stavros AT, Thickman D, Rapp CL, et al. Solid breast nodules: use of sonography to distinguish between benign and malignant lesions. Radiology. 1995;196:123–34.
6. Bassett LW, Kim CH. Breast imaging: mammography and ultrasonography. Magn Reson Imaging Clin N Am. 2001;9:251–71.
7. Schroeder RJ, Bostanjoglo M, Rademaker J, et al. Role of power Doppler techniques and ultrasound contrast enhancement in the differential diagnosis of focal breast lesions. Eur Radiol. 2003;13: 68–79.
8. Leconte I, Feger C, Galant C, et al. Mammography and subsequent whole-breast sonography of nonpalpable breast cancers: the importance of radiologic breast density. AJR Am J Roentgenol. 2003;180:1675–9.
9. Kolb TM, Lichy J, Newhouse JH. Occult cancer in women with dense breasts: detection with screening US – diagnostic yield and tumor characteristics. Radiology. 1998;207:191–9.
10. Kolb TM, Lichy J, Newhouse JH. Comparison of the performance of screening mammography, physical examination, and breast US and evaluation of factors that influence them: an analysis of 27,825 patient evaluations. Radiology. 2002; 225:165–75.
11. Saarenmaa I, Salminen T, Geiger U, et al. The effect of age and density of the breast on the sensitivity of breast cancer diagnostic by mammography and ultrasonography. Breast Cancer Res Treat. 2001;67:117–23.
12. American College of Radiology. BI-RADS: ultrasound, 1st ed. In: Breast Imaging Reporting and Data System: BI-RADS atlas, 4th ed. Reston: American College of Radiology; 2003.
13. Colégio Brasileiro de Radiologia. BI-RADS – Sistema de laudos e registro de dados de imagem da mama. São Paulo: Colégio Brasileiro de Radiologia; 2005.
14. Miller AB, To T, Baines CJ, et al. Canadian National Breast Screening Study-2: 13-year results of a randomized trial in women aged 50-59 years. J Natl Cancer Inst. 2000;92:1490–9.
15. Costantini M, Belli P, Lombardi R, et al. Characterization of solid breast masses: use of the sonographic breast imaging reporting and data system lexicon. J Ultrasound Med. 2006;25:649–59.
16. Melhado VC, Alvares BR, Almeida OJ. Correlação radiológica e histológica de lesões mamárias não-palpáveis em pacientes submetidas a marcação pré-cirúrgica, utilizando-se o sistema BI-RADS. Radiol Bras. 2007;40:9–11.
17. Liberman L, Abramson A, Squires FB, et al. The breast imaging report and data system: positive predictive value of mammographic features and final assessment categories. AJR Am J Roentgenol. 1998;171:35–40.
18. Kestelman FP, Souza GA, Thuler LC, et al. Breast Imaging Reporting and Data System – BI-RADS®: valor preditivo positivo das categorias 3, 4 e 5. Revisão sistemática da literatura. Radiol Bras. 2007;40:173–7.
19. Fleury EFC, Rinaldi JF, Piato S, et al. Apresentação das lesões mamárias císticas à ultra-sonografia utilizando a elastografia. Radiol Bras. 2008; 41:167–72.
20. Roveda Jr D, Piato S, Oliveira VM, et al. Valores preditivos das categorias 3, 4 e 5 do sistema BI-RADS em lesões mamárias nodulares não-palpáveis avaliadas por mamografia, ultra-sonografia e ressonância magnética. Radiol Bras. 2007;40: 93–8.
21. Ciatto S, Houssami N, Apruzzese A, et al. Reader variability in reporting breast imaging according to BI-RADS assessment categories (the Florence experience). Breast. 2006;15:44–51.
22. Chen SC, Cheung YC, Su CH, et al. Analysis of sonographic features for the differentiation of benign and malignant breast tumors of different sizes. Ultrasound Obstet Gynecol. 2004;23:188–93.
23. Calas MJG, Koch HA, Dutra MVP. Ultra-sonografia mamária: avaliação dos critérios ecográficos na diferenciação das lesões mamárias. Radiol Bras. 2007;40:1–7.