Application of the Breast Imaging Reporting and Data System Final Assessment System in Sonography of Palpable Breast Lesions and Reconsideration of the Modified Triple Test

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Objective. The purpose of our study was to evaluate the utility of the American College of Radiology's Breast Imaging Reporting and Data System (BI-RADS) sonographic final assessment system and palpation-guided fine-needle aspiration (FNA) for evaluation of palpable breast lesions. ***Methods.*** Our computerized database identified 160 palpable lesions of the breast in which follow-up palpation-guided FNA, targeted sonography, and pathologic confirmation were performed. We used BI-RADS sonographic data on all lesions. The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of malignancy were calculated for sonography and palpation-guided FNA. Two-sample binomial proportion tests were used as the statistical analysis ($P < .05$). ***Results.*** The FNA results were defined as benign, atypical cells, suspicious for malignancy, malignancy, and insufficiency. The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were 90.9%, 82.7%, 84.3%, 57.7%, and 97.2%, respectively, on sonography and 75.8% to 90.9%, 82.7% to 98.4%, 84.3% to 94.4%, 57.7% to 92.6%, and 93.9% to 97.2% on FNA. There was no statistically significant difference for sensitivity and negative predictive value between the two examinations. ***Conclusions.*** The diagnostic accuracy of sonography was similar to that of palpation-guided FNA for not missing the malignancy. Clinical application of FNA results can be difficult, especially when the result is insufficiency or atypical cells. Moreover, FNA is invasive and overlaps other procedures. Therefore, we conclude that sonography can replace palpation-guided FNA for diagnosis of palpable lesions of the breast when the BI-RADS sonographic final assessment system is used appropriately. ***Key words:*** breast, neoplasms; breast neoplasms, diagnosis; breast neoplasms, sonography.

Abbreviations
BI-RADS, Breast Imaging Reporting and Data System; FNA, fine-needle aspiration; NPV, negative predictive value; PPV, positive predictive value

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Palpable lesions of the breast are common occurrences at breast clinics. The "triple test" (physical examination, mammography, and fine-needle aspiration [FNA]) was initially described in 1975 for evaluation of palpable breast lesions.[1] After that, many reports supported the usefulness of the triple test.[2–5] In 1996, a modified triple test replaced mammography with sonography for palpable breast masses in younger women.[6]

With improvement of imaging equipment and techniques, some reports have shown that negative mammographic and sonographic results make the invasive procedure superfluous.[7–9] Nevertheless, for diagnosing palpable breast lesions, many overlapping examinations are still done, including palpation-guided FNA, imaging studies, and pathologic confirmation.

Until now, application of the American College of Radiology's Breast Imaging Reporting and Data System (BI-RADS) has been limited primarily to mammography. Recently, the American College of Radiology introduced application of the BI-RADS to sonography.[10] To our knowledge, little evidence exists about the application of the BI-RADS sonographic final assessment system to palpable breast lesions. Therefore, this study was designed to evaluate the effectiveness of the BI-RADS sonographic final assessment system and to reconsider the diagnostic algorithm for palpable breast lesions.

Materials and Methods

Our computerized database identified 160 palpable lesions of the breast on physical examination in which palpation-guided FNA, targeted sonography, and pathologic confirmation were performed. We reviewed data from May 1, 2002, through October 1, 2004. This period included 408 palpable lesions of the breast (384 female patients). Palpation-guided FNA was done in 188 cases. Among the total cases reviewed, this study included 160 palpable breast lesions (151 patients) that underwent the modified triple test (physical examination, sonography, and FNA) and pathologic confirmation. The mean age of the patients was 34 years, with a range of 14 to 73 years. The palpable lesions ranged in size from 6 to 65 mm (mean, 23.3 mm). We excluded simple cysts on sonography.

Mammography

Mammographic examinations in this study were performed with dedicated mammography units (Senographe DMR, GE Healthcare, Milwaukee, WI). Standard craniocaudal and mediolateral oblique views were routinely obtained, and additional mammographic views were obtained as needed. Mammographic examinations were performed on 132 patients. The remaining 28 patients did not undergo mammographic examinations because of very young age and loss of outside mammography services. Each study was interpreted by an expert breast imager (J.Y.K.). The location of palpable abnormalities was indicated by metallic BB markers or clinical notes.

Sonography

We routinely performed a focused sonographic examination that targeted the area of clinical concern. The sonographic examination was performed by the same radiologist (J.Y.K.) who interpreted the mammogram, usually immediately after reviewing the mammogram. Therefore, each sonographic examination was performed with full knowledge of the clinical and mammographic findings. Each patient was evaluated with real-time sonography using an HDI 3000 or HDI 5000 system (Philips Medical Systems, Bothell, WA) with a linear 5- to 12-MHz probe. Routine studies did not include color or power Doppler sonography.

Each lesion was classified according to the BI-RADS sonographic protocol. Category 1 was normal, and category 2 was a benign finding such as a cyst or a nodule with intense homogeneous hyperechogenicity. We used many suspicious sonographic findings, including irregular shape, complex echogenicity, posterior shadowing, spiculated margins, microlobulated margins, nonparallel orientation, microcalcifications, and duct extension. If any suspicious finding was present, the lesion was categorized as 4. When a mass had 3 or more suspicious findings, it was categorized as 5. If a mass detected on sonography was not categorized as 2, 4, or 5, it classified as category 3.[11] Interpretation of sonography was performed prospectively. Fine-needle aspiration results were interpreted by an experienced breast cytopathologist (J.-Y.K.).

Fine-Needle Aspiration

In our hospital, FNA is an office-based procedure with palpation guidance. This procedure was performed by an experienced breast surgeon (H.-L.P.) with a 20-gauge needle and an aspirator. This procedure was done after imaging studies (mammography, sonography, or both), not disturbing the interpretation of the images.

Histopathologic Confirmation

Pathologic confirmations were done with a sonographically guided 14-gauge automated gun biopsy (37 cases), 11- or 8-gauge vacuum-assisted biopsy (37 cases), or excision (86 cases). The surgeon chose the biopsy method, especially with

the presentation of benign characteristics in the modified triple test and mammography. In 74 patients who chose to undergo needle biopsy, a short-term follow-up study with sonography was recommended for the first 2 years. Thereafter, we performed scheduled screening follow-up, with a follow-up duration of about 12 to 32 months (mean, 26 months).

Statistics

The sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of malignancy were calculated for sonography and palpation-guided FNA. Two-sample binomial proportion tests were used for the statistical analysis ($P < .05$) to compare sonography and palpation-guided FNA.

Results

Histopathologic Confirmation

There were 33 malignant and 127 benign results (Table 1). Table 2 shows the age distribution of the patients studied. Patients younger than 30 years constituted 38.8% of the patients in this study. The percentage of malignancy increased according to age.

Table 1. Results of 160 Pathologic Examinations of Palpable Breast Lesions

Lesion	n
Malignancy	33
Invasive ductal carcinoma, NOS	29
Invasive ductal carcinoma, atypical medullary	1
Malignant phyllodes tumor	2
Ductal carcinoma in situ	1
Benign	127
Fibroadenomas	68
Fibroadenomatous hyperplasia	13
Benign phyllodes tumors	11
Fibrocystic changes	9
Adenosis tumors	3
Intraductal papillomas	3
Lactating adenomas	3
Duct ectasia	3
Periductal chronic inflammation	3
Fibrosis	1
Florid papillomatosis	1
Nodular adenosis	1
Sclerosing adenosis	1
Sclerosing lobular hyperplasia	1
Sclerosing papilloma	1
Ductal hyperplasia	1
Hamartoma	1
Intraductal hyperplasia	1
Benign inflammation	1
Biphasic tumor	1

DCIS indicates ductal carcinoma in situ; and NOS, not otherwise specified.

Mammography and Sonography

Among these 160 lesions, mammography was available for 132 cases (99 benign cases and 33 malignant cases). In 4 cases, both mammographic and sonographic findings were negative. Three cases showed a heterogeneously dense breast, and the remaining breast was extremely dense. In all of them, the findings were confirmed as negative by excision despite negative imaging findings because of a high degree of clinical suspicion or patient anxiety. The pathologic results were fibrocystic change (2 cases), fibroadenoma (1 case), and periductal chronic inflammation (1 case). Five (15.2%) of 33 malignancies had negative mammographic findings, even with the presence of a metallic BB marker on mammography.

Analysis of Cytologic Examination and Sonography

The results of the palpation-guided FNA were defined as benign, atypical cells, suspicious for malignancy, malignancy, and insufficiency. The analysis of palpable lesions on sonography used the BI-RADS sonographic final assessment system. Interpretations were classified as categories 1 through 5.

The cytologic results of 4 cases with normal mammographic and sonographic findings were 1 atypical cell, 1 insufficiency, and 2 benign findings.

There were 11 cancers (61.1%) among the 18 patients in whom the palpable abnormality showed atypical cells or was suspicious for malignancy on FNA. Ten (90.9%) of 11 cancers were classified as category 4 on sonography; the remaining cancer was classified as category 3 (Table 3). Seven (38.9%) of 18 patients received a

Table 2. Percentage of Malignancy According to Age Distribution

Patient Age, y	No. of Cases	Malignancy, % (n)
10–19	8	0 (0/8)
20–29	54	3.7 (2/54)
30–39	52	11.5 (6/52)
40–49	25	44 (11/25)
50–59	18	61.1 (11/18)
60–69	2	100 (2/2)
70–79	1	100 (1/1)

Table 3. Sonographic Categorization and Pathologic Results for Atypical Cells and Suggestion of Malignancy on FNA

Case	Age, y	Cytologic Results	Sonographic Category	Pathologic Results
1	48	Atypical cells	4	IDC, NOS
2	28	Atypical cells	4	IDC, NOS
3	40	Atypical cells	4	IDC, NOS
4	44	Atypical cells	4	IDC, NOS
5	56	Suspicious for malignancy	4	IDC, NOS
6	44	Suspicious for malignancy	4	IDC, NOS
7	35	Suspicious for malignancy	4	IDC, NOS
8	46	Suspicious for malignancy	4	IDC, NOS
9	61	Suspicious for malignancy	4	IDC, NOS
10	54	Suspicious for malignancy	4	IDC, NOS
11	53	Suspicious for malignancy	3	IDC, NOS
12	22	Atypical cells	1	Fibroadenoma
13	43	Atypical cells	3	Intraductal papilloma
14	26	Atypical cells	4	Sclerosing papilloma
15	42	Atypical cells	3	Intraductal papilloma
16	31	Atypical cells	3	Fibroadenoma
17	23	Suspicious for malignancy	4	Benign phyllodes tumor
18	33	Suspicious for malignancy	3	Intraductal papilloma

IDC indicates invasive ductal carcinoma; and NOS, not otherwise specified.

diagnosis of a benign condition in the area of the palpable abnormality despite atypical cells or suspicion of malignancy on FNA. Among these 7 cases, 5 (71.4%) were scored as category 3 on sonography (Table 3).

There were 2 (11.8%) cancers among 17 patients in whom the palpable abnormality showed insufficiency on FNA (Table 4). Each was classified as category 4 on sonography. Fifteen (88.2%) of 17 patients received a diagnosis of a benign condition in the area of the palpable abnormality. Among these 15 cases, 13 (86.7%) were classified as category 1, 2, or 3 on sonography.

Table 4. Sonographic Categorization and Pathologic Results for Insufficiency on FNA

Case	Age, y	Sonographic Category	Pathologic Results
1	28	3	Fibrocystic change
2	42	4	Periductal chronic inflammation
3	38	1	Fibrocystic change
4	48	4	IDC, NOS
5	22	3	Fibroadenomatous hyperplasia
6	53	3	Ductal hyperplasia
7	35	3	Fibroadenoma
8	35	3	Fibroadenoma
9	30	3	Fibroadenoma
10	29	3	Fibroadenoma
11	47	3	Florid papillomatosis
12	53	3	Fibrocystic change
13	20	3	Fibroadenoma
14	55	4	Duct ectasia
15	56	2	Fibroadenoma
16	43	3	Fibrosis
17	73	4	IDC, NOS

IDC indicates invasive ductal carcinoma; and NOS, not otherwise specified.

Statistics

When atypical results from the cytologic examinations were classified as negative, and insufficient samples were classified as positive or negative or excluded, the sensitivity, specificity, accuracy, PPV, and NPV were calculated (Table 5). When atypical results from the cytologic examinations were classified as positive, and insufficient samples were classified as positive or negative or excluded, the sensitivity, specificity, accuracy, PPV, and NPV were also calculated (Table 5). When the palpable breast lesions on sonography were interpreted according to the BI-RADS sonographic final assessment, the sensitivity, specificity, accuracy, PPV, and NPV were calculated (Table 5). There was no statistical significant difference for sensitivity and NPV between the two examinations ($P > .05$; Table 5).

Discussion

With improvements in technology and careful real-time evaluation, sonography is emerging as an important diagnostic tool in young women and an adjunctive method to mammography in older women. Moreover, negative results of combined studies, including mammography and sonography, show a nearly 100% NPV for palpable breast lesions.[7–9,12,13]

In our hospital, many women with palpable breast lesions evaluated with the triple or modified triple test have chosen pathologic confirmation rather than imaging follow-up. Although a recent study suggested that palpable noncalcified solid breast masses with benign morphologic characteristics on mammography and sonography could be managed similarly to nonpalpable BI-RADS category 3 lesions, with short-term follow-up,[14] pathologic confirmation was chosen for benign-looking masses because of patient anxiety, clinician concern, or both. As a result, many procedures overlapped for diagnosis and treatment of the breast lesions. In this study, 188 (46.1%) of 408 palpable breast lesions were evaluated with palpation-guided FNA. One hundred sixty (85.1%) of the 188 lesions also underwent pathologic confirmation. Such an overlap of diagnostic procedures increases the patient's cost burden and may cause unnecessary discomfort.

In this study, 160 palpable breast lesions underwent physical examination, palpation-guided FNA, sonography, and confirmative biopsy or surgery. Many palpable breast lesions were found to be benign (79.38%), in concordance with previous reports[15,16] of about 79.4% benign conditions in palpable breast lesions.

We compared sonography and many combined FNA results. The sensitivity, specificity, accuracy, PPV, and NPV were 90.9%, 82.7%, 84.3%, 57.7%, and 97.2%, respectively, on sonography and 75.8% to 90.9%, 82.7% to 98.4%, 84.3% to 94.4%, 57.7% to 92.6%, and 93.9% to 97.2% on palpation-guided FNA (Table 5). There was no statistically significant difference for sensitivity and NPV between the two examinations. Although in some combined FNA results, specificity, accuracy, and PPV were superior to those of sonography, it is impossible to adjust these complex FNA results in practical patient care. Also, in the objective of not missing malignancy, sensitivity and NPV are most important. Our study revealed no statistical differences between FNA and sonography for sensitivity and NPV ($P > .05$).

When cytologic results revealed insufficiency, atypical cells, and suspicion of malignancy, sonographic categorization provided good guidance for managing palpable abnormalities.

Table 5. Comparison of Sonography With FNA Cytologic Examination for Test Outcomes

		FNA					
		Atypical Cells Are Classified as Negative			Atypical Cells Are Classified as Positive		
Outcome	Sonography	Insufficiency Classified as Positive	Insufficiency Classified as Negative	Insufficiency Excluded	Insufficiency Classified as Positive	Insufficiency Classified as Negative	Insufficiency Excluded
Sensitivity, %	90.9	81.8	75.8	80.6	90.9	84.8	90.3
Specificity, %	82.7	86.6	98.4*	98.2*	82.7	94.5*	93.8*
Accuracy, %	84.3	85.6	93.8*	94.4*	84.3	92.5*	93*
PPV, %	57.7	61.4	92.6*	92.6*	57.7	80*	80*
NPV, %	97.2	94.8	93.9	94.8	97.2	96	97.2

*Statistically significant compared with results of sonography ($P < .05$).

In this study, when the palpable abnormality was characterized as having atypical cells or as being suspicious for malignancy on FNA, 10 (90.9%) of 11 cancers were classified as category 4 on sonography. Of the 18 cases in which FNA results were reported as atypical cells or suspicion of malignancy, 7 had benign conditions. Of these 7 cases, 5 (71.4%) were classified as category 1 or 3 on sonography, indicating the possibility of false-positive cytologic results. When the palpable abnormality showed insufficient results on FNA, 2 (100%) of 2 cancers were classified as category 4 on sonography.

Among the 160 palpable breast lesions in our study, mammography was available for 132 cases (99 benign cases and 33 malignant cases). About 15% (5/33 cases) of malignancies were mammographically occult, similar to findings in other reports.[17,18] These 5 cases had heterogeneously dense breast tissue. There were 4 negative results on mammography and sonography. All 4 cases had heterogeneously or extremely dense breasts, and all 4 were confirmed by excision despite negative imaging findings because of a high degree of clinical suspicion or patient anxiety. The cytologic results of these 4 cases were 1 atypical cell, 1 insufficiency, and 2 benign findings. The confirmatory diagnoses of these cases were benign conditions (2 fibrocystic changes, 1 fibroadenoma, and 1 periductal chronic inflammation). Although small in number, our results support other studies in which the NPV of negative mammographic and sonographic findings was 100%.[7–9,12,13] Moreover, despite assessment by an experienced cytopathologist, FNA cytologic examination was not a reliable diagnostic method.

There were several limitations in our study. First, the period of imaging follow-up (12–32 months) was insufficient in some cases. We selected for the methods of pathologic confirmation a 14-gauge automated gun, 11- or 8-gauge vacuum assisted biopsy, and surgery. Although many reports have shown a high level of accuracy with image-guided needle biopsy,[19–24] continuous imaging follow-up is needed. However, there were no malignancies discovered at excision or during follow-up of benign lesions. Second, our study was based on examination of the data by breast specialists (an expert surgeon and an expert radiologist skilled in breast imaging). These data therefore may not be reproducible in other institutions. Third, our data group was a little small; therefore, further investigation with a larger data set is needed.

Many palpable breast lesions, even those with demonstrably benign findings, have been removed by vacuum-assisted needle excision or surgical excision because of patient anxiety, physician concern, or both. We found that the application of the BI-RADS sonographic final assessment system to palpable breast lesions was similar to FNA except for some combined FNA applications. The application of FNA results can be difficult, especially when the result is insufficiency and atypical cells. Moreover, FNA is invasive and overlaps other procedures. Therefore, we conclude that sonography can replace palpation-guided FNA for diagnosis of palpable lesions of the breast when sonographic examinations are done meticulously.

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