

Sonographic Detection and Sonographically Guided Biopsy of Breast Microcalcifications

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OBJECTIVE. The purpose of this study was to evaluate the ability of sonography to depict and guide biopsies of mammographically suspicious microcalcifications and to reveal the mammographic features and histologic outcomes of lesions amenable to sonographically guided biopsy.

SUBJECTS AND METHODS. Suspicious clusters of microcalcifications without other mammographic abnormalities were evaluated on sonography before biopsy and divided into two groups: those with and those without microcalcifications seen on sonography. Sonographically detected lesions underwent sonographically guided biopsy; lesions not seen on sonography underwent mammographically guided biopsy. Imaging features and histologies were correlated, and the positive predictive value of sonography was determined.

RESULTS. Of 111 lesions (105 patients), 26 lesions (23%) were identified and underwent sonographically guided biopsy; 85 lesions (77%) were not identified sonographically. The diameters of microcalcification clusters in the sonographically identified group were significantly larger ($p = 0.0005$) and contained larger numbers of microcalcification particles ($p = 0.038$) compared with clusters not identified sonographically. Sonographically identified lesions were seen as masses (77%) or dilated ducts (23%) with echogenic foci. Sonographically identified lesions were more likely to be malignant than those not seen on sonography (69% vs 21%, respectively; $p < 0.00002$). Of 38 malignant lesions, those visible on sonography were more likely to be invasive than those not seen on sonography (72% vs 28%, respectively; $p = 0.018$). In malignant lesions undergoing core biopsy and surgical excision, the extent of disease was underestimated less with sonographically guided biopsy (7%, 1/15) than with stereotactic biopsy (33%, 5/15).

CONCLUSION. Suspicious microcalcifications are seen infrequently on sonography (23%) but, when detected, can be successfully biopsied with sonographic guidance and more frequently are malignant and represent invasive cancer than those seen on mammography alone.

Mammographically revealed, suspicious clustered microcalcifications that have no associated mammographic features are usually diagnosed by either percutaneous core needle biopsy with stereotactic guidance or at surgical excision after mammographically guided wire localization. Although both techniques are successful for aiding in diagnosis of these lesions [1], the techniques require mammographic compression of the breast that is uncomfortable for the patient, and they expose the breast to ionizing radiation. Many stereotactic biopsies are performed with the patient in a prone position, which is often considered uncomfortable and in some cases is difficult or impossible for patients to tolerate. In addition, mammographic

compression can make the breast too thin to allow successful core needle biopsy of a lesion. Finally, stereotactic biopsy equipment is expensive and not universally available.

Sonography is frequently used to guide percutaneous core biopsy or wire localization before excisional biopsy of breast masses [1]. In general, sonographically guided procedures are preferred by patients over mammographically guided procedures because patients are more comfortable supine, the breast is not compressed, and the procedures are often performed faster [1, 2]. In addition, no ionizing radiation is used, the needle insertion site is more flexible, and the needle can be observed in real time with sonographically guided procedures [1, 2].

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Recently, a study of suspicious microcalcifications undergoing mammographically guided wire localization was performed to evaluate sonographic detection of these lesions [3]. In this study, 45% of lesions were seen on sonography and were confirmed to be at the site of mammographically guided wire placement [3]. Other studies have shown that sonography can be used successfully to guide core biopsy of lesions shown on sonography to contain microcalcifications [2, 4, 5]. We undertook this study to determine what percentage of suspicious microcalcifications could be seen on sonography and then successfully sampled with sonographic guidance; we evaluated the mammographic features and histologic outcome of those lesions that were amenable to sonographically guided detection and biopsy.

Subjects and Methods

During an 11-month period, 110 patients with 116 suspicious groups of microcalcifications that were recommended for biopsy consented to enter our prospective, institutional review board-approved study to determine if the suspicious microcalcifications were visible on sonography and amenable to sonographically guided biopsy. To be invited into the study, patients had to be scheduled for biopsy of mammographically visible microcalcifications without associated mammographically identified masses or architectural distortions. Before biopsy, sonography targeted to the site of microcalcifications was performed. Each lesion was then placed into one of two groups after completion of sonography: those with microcalcifications detected on sonography or those with no microcalcifications identified on sonography. Lesions visible on sonography subsequently underwent sonographically guided biopsy, with either percutaneous core biopsy or wire localization with surgical excision. Specimen radiography and postprocedure mammography were performed to confirm that the microcalcifications were sampled. Lesions not depicted on sonography underwent either stereotactic biopsy or mammographically guided wire localization with surgical excision and specimen radiography. Four of the 110 patients were excluded from the study because the subsequent biopsy was not performed under sonographic guidance in patients in whom microcalcifications were visible on sonography. One patient was excluded from those with the group of lesions not seen on sonography because stereotactic biopsy could not be performed; the patient chose to undergo imaging follow-up rather than excisional biopsy. The remaining 105 patients with 111 suspicious groups of microcalcifications constituted our study population.

Mammography was performed using a film-screen technique (Mammomat II, Mammomat III, Mammomat 3000, Siemens Medical Solutions, Iselin, NJ; DMR Plus, General Electric Medical Systems, Milwaukee, WI). Standard mediolateral oblique and craniocaudal images of the breasts were obtained in each patient; additional spot compression magnification images of areas of microcalcifications were also obtained in all except three patients.

Sonograms targeted to the site of microcalcifications were obtained using high-resolution sonography equipment (Elegra; Siemens Quantum, Isquah, WA) with a commercially available 13.5-MHz 1.5 dimensional linear array probe. All sonographic evaluations were performed with the patient supine with the ipsilateral arm raised above the head. Images were obtained in planes radial and antiradial to the nipple in the region of the mammographic microcalcifications.

Percutaneous core biopsies were performed under sonographic guidance for lesions visible on sonography and under stereotactic guidance for lesions not visible on sonography using techniques previously described [1, 2]. For microcalcifications that underwent core biopsy under sonographic guidance, high-resolution sonographic equipment (Siemens Medical Solutions, USA, Iselin, NJ) and a 13.5-MHz 1.5 dimensional linear array probe was used with either a multipass automated gun and a 14-gauge needle (Bard, Covington, GA) ($n = 7$) or a handheld vacuum-assisted device with an 11-gauge probe (Mammotome; Biopsys/Ethicon Endo-Surgery, Cincinnati, OH) ($n = 18$). The choice of biopsy device was based on the preference of the radiologist performing the procedure. For microcalcifications seen on mammography alone, stereotactic biopsy was performed using either a prone table (Stereoguide with digital spot mammography; Lorad, Danbury, CT) or an upright add-on stereotactic device (Senovision, DMR, General Electric Medical Systems). For all stereotactic biopsies, a vacuum-assisted biopsy device with an 11-gauge probe was used to sample the calcifications. After core biopsy in each group, specimen radiography was performed to confirm the presence of microcalcifications, and postprocedure mammograms were obtained to ensure that the suspicious group of microcalcifications seen on mammography was sampled. The number of core specimens obtained during each biopsy was recorded and compared between the groups.

Wire localization before surgical excision was performed using a 21-gauge hooked wire needle (Kopans; Cook, Bloomington, IN). For wire localizations performed under sonographic guidance, high-resolution sonography equipment and a 13.5-MHz 1.5 dimensional linear array probe were used to guide needle placement. For lesions not seen on sonography, a fenestrated compression paddle with an alphanumeric grid was used to guide needle placement. Postprocedure craniocaudal and true lateral mammograms were obtained after wire placement to confirm localization of the microcalcifications and to provide the surgeon with reference images. Specimen radiography was then performed after surgical excision to confirm the presence of microcalcifications in the specimen.

The percentage of sonographically detected microcalcification clusters was calculated. The imaging features of the two groups were then compared on the basis of mammographic breast density, largest diameter of the group of microcalcifications, number of microcalcifications per group, microcalcification morphology and distribution, and Breast Imaging Reporting and Data System (BI-RADS) [6] final assessment category. On mammography, the size of the group of microcalcifications was measured as the greatest diameter of the group in either mediolateral oblique or craniocaudal projections. The number of microcalcifications in each group was assessed on magnification images and categorized as fewer than 15 microcalcifications, 15–50 microcalcifications, or more than 50 microcalcifications. The breast density based on the four BI-RADS parenchymal patterns (predominantly fatty, scattered fibroglandular density, heterogeneously dense, or extremely dense tissue) was recorded. Microcalcification morphology was determined according to BI-RADS descriptors: pleomorphic, amorphous, fine linear-branching, round, or punctate. Distribution of microcalcifications was also based on BI-RADS descriptors: clustered, linear, segmental, or regional.

On sonography, any finding associated with the microcalcifications was recorded, including masses or dilated ductlike structures not seen on mammography. The size of the mass or dilated duct that contained the microcalcifications was assessed on the basis of the largest size measured on static images, and this size was compared with the diameters of the group of microcalcifications seen on mammography.

Histologic results from each core biopsy and surgical excision were reviewed. The positive predictive values of sonography and mammography for this population were calculated, and the sensitivity, specificity, and negative predictive value of sonography were determined. For patients in each group undergoing core biopsy of the microcalcifications followed by surgical excision, the percentage of cases in which final surgical pathology results showed that the core biopsy underestimated the disease process (e.g., atypical ductal hyperplasia identified at core biopsy but ductal carcinoma in situ [DCIS] diagnosed at surgery, or DCIS identified at core biopsy but invasive ductal carcinoma diagnosed at surgery) was compared between the groups.

The Fisher's exact test, the Wilcoxon's signed rank test, and the Mann-Whitney test were used to compare differences between groups, and the Cochran-Mantel-Haenszel statistics based on table scores were used to test for a monotonic ordered relationship among variables. Findings with a p value of less than 0.05 were considered to be statistically significant.

Results

Of 111 mammographically suspicious microcalcification lesions in 105 patients, 26 lesions (23%) were identified as masses or ducts with microcalcifications and biopsied under

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sonographic guidance. In 85 lesions (77%), no masses or microcalcifications were identified on sonography. One patient had one lesion seen on sonography and two lesions not seen on sonography. In no patients did findings on sonography show a suspicious mass without microcalcifications in the targeted area; however, in two patients in whom sonography showed a mass with microcalcifications, an additional incidental mass was seen in an adjacent region. Each mass proved to be a complicated cyst at sonographically guided biopsy of the lesion. In the group of patients with 26 lesions that underwent sonographically guided biopsy, the mean patient age was 61 years (age range, 38–81 years), and in the group of patients with 85 lesions that underwent mammographically guided biopsy, the mean patient age was 55 years (age range, 39–86 years).

Table 1 lists the mammographic parenchymal density, mammographic features of the microcalcifications undergoing biopsy, and the BI-RADS assessment categories for each group. No statistically significant difference in the breast parenchymal density was found between the two groups ($p = 0.951$). No mass or architectural distortion was identified on mammography in association with the microcalcifications, although the microcalcifications were often seen in a background of fibroglandular density.

In the group of microcalcifications seen on sonography, the mammographic diameters of the clusters of microcalcifications were significantly larger than those clusters not identified on sonography ($p = 0.0005$). The microcalcifications seen on sonography also had significantly more microcalcifications per cluster than those not seen on sonography ($p = 0.038$). Segmentally distributed microcalcifications were found only in the group of microcalcifications seen on sonography, which was statistically significant ($p = 0.012$). There was no significant correlation with other morphologic features of the microcalcifications on mammography.

BI-RADS category 5 lesions (highly suggestive of malignancy) were significantly more likely to be seen on sonography (Fig. 1) than not seen on sonography ($p < 0.00003$), with 89% (8/9) of all BI-RADS category 5 lesions identified on sonography. BI-RADS category 4 lesions seen on sonography (Fig. 2) had a greater likelihood of being malignant (59%, 10/17) than did BI-RADS category 4 lesions not seen on sonography (21%, 17/81).

The mammographic lesions shown on sonography were seen as echogenic foci within either hypoechoic (95%) or isoechoic

(5%) masses (77%), or within hypoechoic dilated ductlike structures (23%). The mean size of the abnormal sonographic finding (mass or duct with microcalcifications, 16 mm) was less than that of the corresponding mammographic group of microcalcifications (23 mm), although the difference was not statistically significant ($p = 0.10$). Seventy-one percent of masses showed posterior acoustic shadowing, and 83% of these were malignant. The masses were either irregular (89%) or lobular (11%), and either wider than tall (75%) or taller than wide (25%). Seventy-two percent of the wider-than-tall masses, a feature that is often associated with benign lesions, proved to be malignant. However, the margin of these masses suggested a malignant process in each, classified as ill-defined, angular, microlobulated, or duct extension.

Of 25 core biopsies performed in the group of microcalcifications seen on sonography, an 11-gauge vacuum-assisted device was used in 18 biopsies (72%) and a 14-gauge multipass gun was used in seven biopsies (28%). A mean of eight cores was taken, using each device. The outcome of each sonographically guided procedure was considered successful, confirmed with specimen radiographs showing microcalcifications in all cases (96%) except one. In the one lesion in which no microcalcifications were identified on the specimen radiograph, a large hypoechoic mass associated with the microcalcifications on sonography was successfully targeted and sampled, although microcalcifications were not retrieved despite multiple attempts (Fig. 3). Nevertheless, DCIS was confirmed at histology. In the one wire localization pro-

TABLE I Mammographic Features of Microcalcifications

Size	On Sonography			
	Visible	Not Visible		
Size of microcalcification groups ^a				
Mean size (mm)	23	9		
Size range (mm)	3–90	2–45		
Features	No.	%	No.	%
Breast parenchymal density pattern				
Predominantly fatty	0	0	2	2
Scattered fibroglandular density	8	31	24	28
Heterogeneously dense	13	50	40	47
Extremely dense	5	19	19	22
No. of microcalcifications ^a				
<15	11	42	37	44
15–50	7	27	36	43
>50	8	31	11	13
Distribution of microcalcifications				
Clustered	19	73	81	95
Linear	1	4	1	1
Segmental ^a	3	12	0	0
Regional	3	12	3	4
Microcalcification morphology				
Punctate	1	4	8	9
Round	1	4	4	5
Amorphous	3	12	12	14
Pleomorphic	18	69	58	68
Fine linear-branching	3	12	1	1
BI-RADS assessment category				
3	1	4	3	4
4	17	65	81	95
5 ^a	8	31	1	1

Note.—BI-RADS = Breast Imaging Reporting and Data Systems [6].

^aSignificant difference noted between groups with $p < 0.05$.

cedure performed with sonographic guidance before surgical excision (core biopsy was never requested in this patient), microcalcifications were identified on the specimen radiograph.

In the group of lesions not seen on sonography, 73 (91%) of 80 attempted stereotactic core biopsies were performed successfully using an 11-gauge vacuum-assisted device. More core specimens were obtained during stereotactic biopsy of lesions in this group (range, 5–28; mean number of cores, 11) compared with the group seen on sonography and biopsied with sonographic guidance (range, 5–15; mean number of cores, 8) ($p = 0.001$). Seven (9%) of 80 attempted stereotactically guided procedures were terminated because the lesion was either too faint or small (size range, 2–8 mm) to be seen on the digital monitor ($n = 6$) or because the breast

became too thin with compression to allow use of the biopsy needle device ($n = 1$). These patients subsequently underwent surgical excision of the lesions.

Of the 26 lesions identified on sonography that subsequently underwent sonographically guided biopsy, 18 (69%) were malignant and eight (31%) were benign. Therefore, a positive finding on sonography in the setting of mammographically suspicious microcalcifications had a positive predictive value of 69% for identifying carcinoma. For suspicious microcalcifications with a negative finding on sonography, mammography had a much lower positive predictive value (21%) in our study. Of the 18 malignant lesions in the group shown on sonography, 17 initially underwent core biopsy before definitive therapy. Of the 17 lesions sampled with core biopsy, two patients

diagnosed with DCIS did not undergo surgical excision during the study period because of other serious medical problems in one and the initiation of neoadjuvant chemotherapy in another who had presented with ipsilateral metastatic axillary lymph nodes positive for adenocarcinoma. The follow-up in this patient occurred at an outside facility. Of the remaining 15 malignant lesions that were initially sampled with core biopsy, the extent of disease was underestimated at initial core biopsy in one case (7%) of atypical ductal hyperplasia that was upgraded to DCIS at excision (Table 2).

Of 85 lesions (80 patients) that were not identified on sonography, 18 (21%) were malignant and 67 (79%) were benign. This finding resulted in a negative predictive value for sonography of 79%. Of the 18 malignant lesions, 16 diagnostic stereotactic core biop-

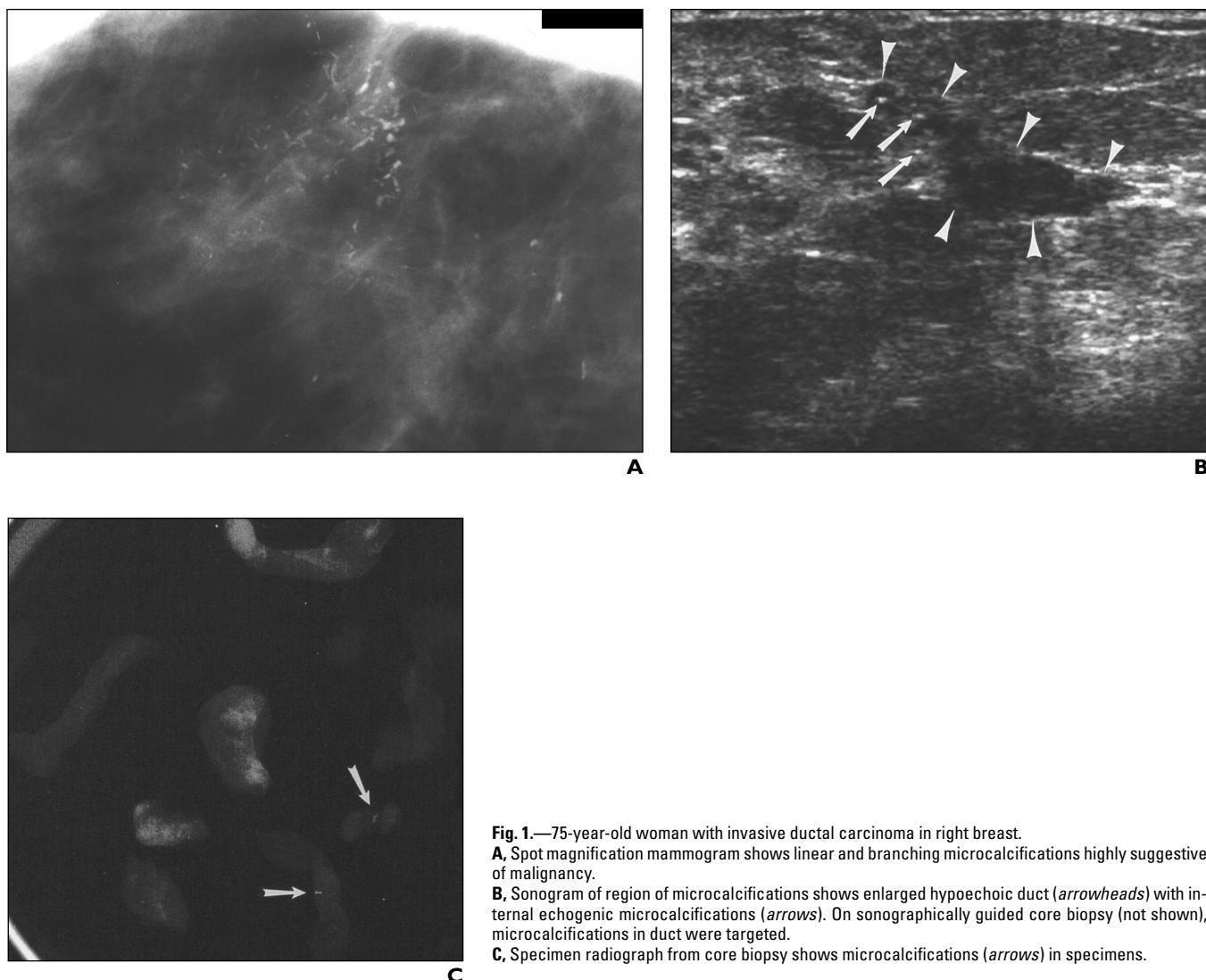


Fig. 1.—75-year-old woman with invasive ductal carcinoma in right breast.
A, Spot magnification mammogram shows linear and branching microcalcifications highly suggestive of malignancy.
B, Sonogram of region of microcalcifications shows enlarged hypoechoic duct (arrowheads) with internal echogenic microcalcifications (arrows). On sonographically guided core biopsy (not shown), microcalcifications in duct were targeted.
C, Specimen radiograph from core biopsy shows microcalcifications (arrows) in specimens.

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sies were attempted initially before definitive therapy. Fifteen were successful, and one was canceled because the breast became too thin with compression to allow use of the biopsy needle device. Of the 15 lesions that were initially sampled with stereotactic core biopsy, the extent of disease was underestimated at initial core biopsy in five (33%), including two cases of atypical ductal hyperplasia that were upgraded to DCIS and three cases of DCIS that were upgraded to invasive ductal carcinoma at excision.

Overall, sonography showed a sensitivity of 50% and a specificity of 89% for detecting carcinoma in cases of suspicious microcalcifications. Lesions identified on sonography were significantly more likely to be malignant than those not seen on sonography (69% vs 21%, respectively; $p < 0.00002$). Of all malignant lesions, those seen on sonography were significantly more likely to be invasive than those not seen on sonography (72% vs 28%, respectively; $p = 0.018$). Less underestimation of disease occurred in the group

of lesions biopsied under sonographic guidance compared with the group biopsied under stereotactic guidance, although this difference did not achieve statistical significance ($p = 0.17$).

Discussion

In the past decade, great strides have been made in improving resolution and contrast in breast sonography, allowing better and more frequent visualization of breast microcalcifications [2, 3, 7, 8]. When they are detected, breast microcalcifications are seen on sonography as distinct echogenic specular reflectors, contrasting with a background hypoechoic mass or ductlike structure that increases microcalcification conspicuity [2, 3]. In our study, we found these same sonographic features to be present in lesions detected on sonography. Less commonly, microcalcifications can appear as broader echogenic regions without a significant associated mass or duct [2]. On sonography, de-

tection of microcalcifications, which was previously limited to mammographically guided techniques, provides the opportunity for biopsy of these lesions under sonographic guidance [2].

In our study, 23% of microcalcifications without other mammographic findings were identified on sonography, and sonographic guidance was used successfully to guide the biopsy using core biopsy or wire localization techniques. Few false-positive sonograms have a specificity of 89%. The mammographic features of the microcalcifications that were most predictive of sonographic identification included large size of the microcalcification group, large number of calcific particles in the group, BI-RADS category 5 lesions, and segmental distribution of microcalcifications. These features are consistent with a previous report that found that the visibility of masses on sonography corresponding to areas of clustered microcalcifications was much higher with highly suspicious microcalcifications, particularly those larger than 10 mm [3]. These

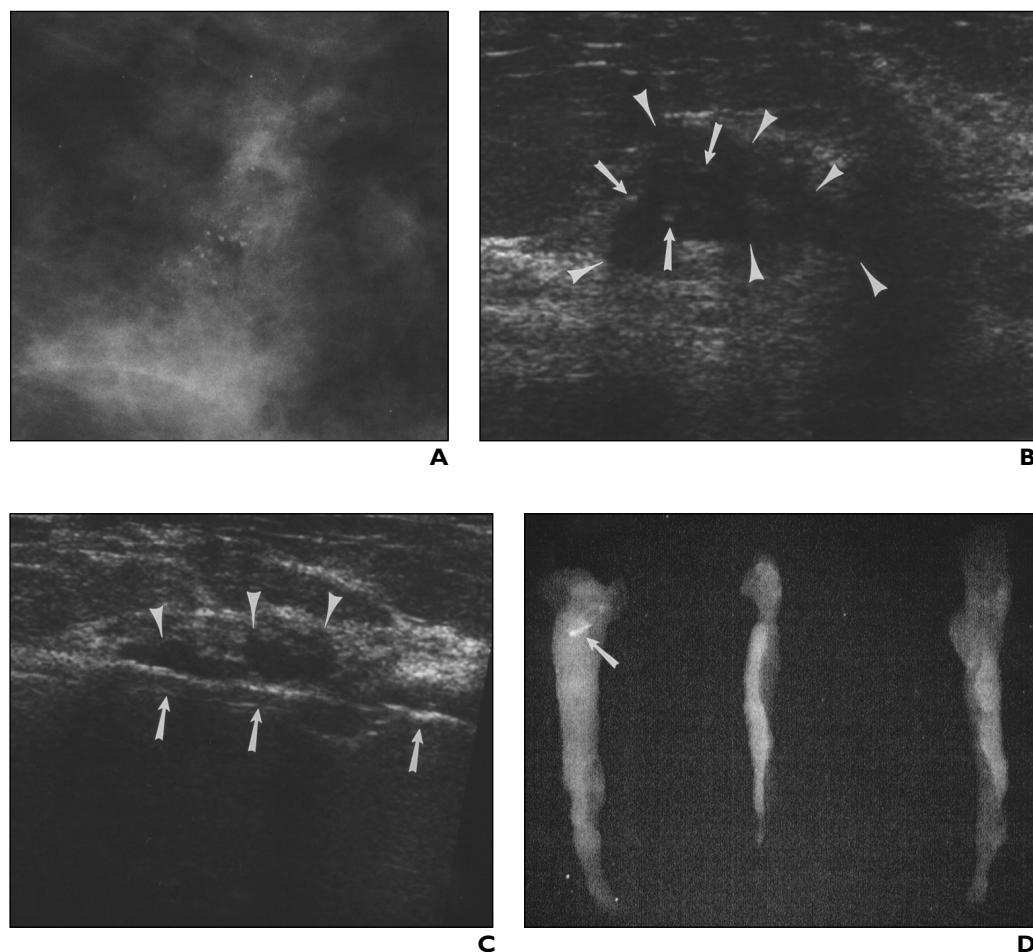


Fig. 2.—73-year-old woman with invasive ductal carcinoma in right breast.

A. Spot magnification mammogram shows pleomorphic microcalcifications suspicious for malignancy.

B. Sonogram of region of microcalcifications shows lobulated ill-defined mass (arrowheads) with associated microcalcifications (arrows).

C. Sonogram obtained during core needle biopsy shows needle (arrows) traversing mass (arrowheads).

D. Specimen radiograph from core biopsy shows microcalcification (arrow) in specimen.

larger, more suspicious-appearing lesions found on mammography in our study were probably more predictive that the lesion would be identified on sonography because they correlated with a greater percentage of invasive carcinomas at histology. Invasive carcinomas often present as hypoechoic masses on sonography that sometimes cannot be seen on mammography because they are obscured by regions of dense fibroglandular tissue. It is likely that the hypoechoic background provided by the masses served to increase the conspicuity and detection of the internal echogenic microcalcifications in our study. Microcalcifications shown on sonography were seen as echogenic foci in either hypoechoic or isoechoic masses or hypoechoic ductlike structures in all cases, similar to le-

sions described in previous studies [2, 3]. Even though sonographically depicted masses or ducts containing microcalcifications tended to be smaller than the corresponding mammographic group of microcalcifications in our study and the number of echogenic foci seen on sonography was less than the number of calcific particles seen on mammography, sonographically guided core biopsy was successful in each patient, using either the 11-gauge handheld vacuum-assisted device or the 14-gauge automated multipass gun.

On the basis of the criteria established by Stavros et al. [9], the presence of microcalcifications in a mass on sonography confers a malignant categorization; therefore, all masses identified on sonography in our study showed features that would be considered

suspicious for malignancy. Most masses also showed other suspicious features on the basis of criteria established by Stavros et al., including posterior acoustic shadowing; irregular shape; and ill-defined, angular, microlobulated or duct-extension margins [9]. Seventy-two percent of masses classified as wider than tall were malignant. Wider than tall is a feature that is often associated with benign lesions. However, each of the wider-than-tall lesions possessed other suspicious features that would prompt biopsy, regardless of this more benign finding.

In our study population, a positive sonogram in the setting of mammographically suspicious microcalcifications had a higher positive predictive value than did mammography of suspicious microcalcifications with

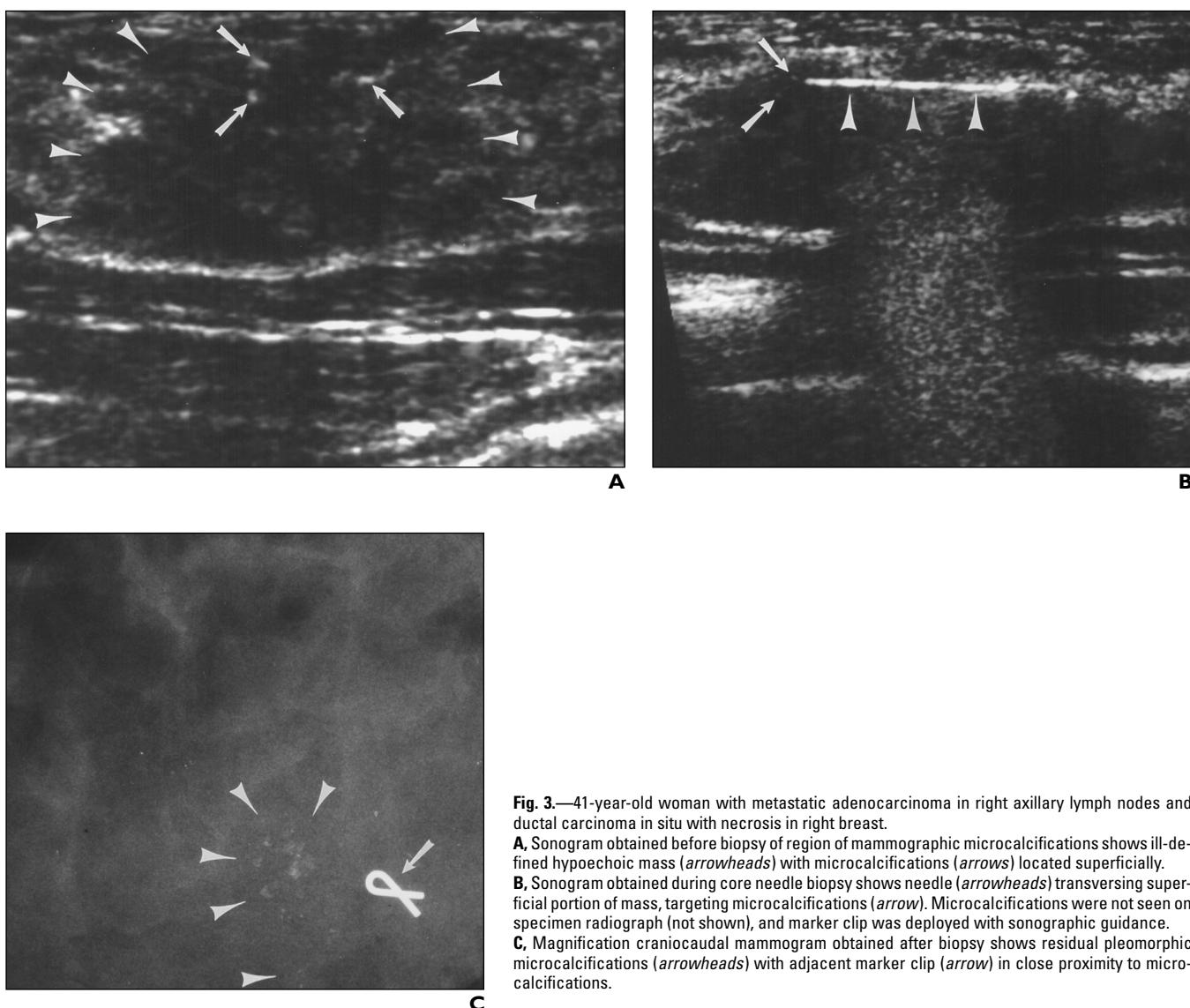


Fig. 3.—41-year-old woman with metastatic adenocarcinoma in right axillary lymph nodes and ductal carcinoma in situ with necrosis in right breast.

A, Sonogram obtained before biopsy of region of mammographic microcalcifications shows ill-defined hypoechoic mass (arrowheads) with microcalcifications (arrows) located superficially.

B, Sonogram obtained during core needle biopsy shows needle (arrowheads) transversing superficial portion of mass, targeting microcalcifications (arrow). Microcalcifications were not seen on specimen radiograph (not shown), and marker clip was deployed with sonographic guidance.

C, Magnification craniocaudal mammogram obtained after biopsy shows residual pleomorphic microcalcifications (arrowheads) with adjacent marker clip (arrow) in close proximity to microcalcifications.

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a negative sonogram (69% vs 21%). Microcalcifications detected on sonography were more than three times as likely to be malignant than microcalcifications not seen on sonography, and lesions detected on sonography were also almost three times more likely to represent an invasive cancer than those seen on mammography alone. Although the positive predictive value was higher in lesions shown on sonography, this group of lesions also contained a larger number of BI-RADS category 5 lesions that were already highly suggestive of malignancy on the basis of the mammographic interpretation. In these few cases, identification of the lesion on sonography would not increase the suspicion of the lesion. However, BI-RADS category 4 lesions that were identified on sonography were much more likely to be malignant than BI-RADS category 4 lesions not identified on sonography (Fig. 2).

Our study showed less underestimation of disease when core biopsy was performed with sonographic guidance, compared with lesions undergoing stereotactically guided biopsy, despite the fact that smaller 14-gauge needles were used in sampling 28% of cases with sonographic guidance and larger 11-gauge probes were used in all stereotactically guided biopsies. The smaller 14-gauge needles used with the multipass automated gun technique have previously been reported to result in more underestimation of disease than the 11-gauge probes used with vacuum-assisted technique on the basis of data from series of stereotactic biopsy cases [10, 11].

This underestimation did not occur in our group biopsied with sonography guidance. Underestimation of disease was lower in our group of statistically larger lesions seen on sonography. This finding differs from that of another recent report suggesting that underestimation of disease during stereotactic biopsy is greater in larger lesions (> 30 mm) [12]. Theoretically, the underestimation of disease normally caused by a sampling error of larger heterogeneous lesions or using smaller 14-gauge needles could be reduced by sampling lesions with sonographic guidance because the hypoechoic masses or duct-like structures seen in addition to echogenic microcalcifications could be directly targeted in real time. In addition, a mass that was seen on sonography but not identified on mammography might represent the higher grade component of the lesion (e.g., invasive component in a large area of DCIS), as has been suggested in a previous report [2]. In our ste-

reotactically guided procedures, no finding other than microcalcifications was seen, and the needle device was guided by static mammographic imaging rather than by real-time imaging. However, the difference in underestimation of disease in our study did not reach statistical significance; therefore, evaluation with a larger sample size would be needed to further investigate this theory. In addition, our study was not a randomized trial to compare sonographically guided biopsy with stereotactically guided biopsy of equal-sized and equivalently categorized BI-RADS lesions. This comparison is necessary to determine if sonographically guided biopsy of microcalcifications truly results in less underestimation of disease.

The obvious limitation to sonographic guidance for biopsy of microcalcifications is that not all groups of microcalcifications can be detected on sonography, with only 23% of cases identified in our study. This percentage is smaller than that reported in a previous study of suspicious microcalcifications undergoing mammographically guided wire localization before excisional biopsy. In that study, sonography was performed before and after wire placement with mammographic guidance, and 45% of lesions were seen on sonography [3]. The method and end point to our study differed in that we were challenged to perform sonographically guided biopsy or wire localization of the lesion detected, confirming the lesion by specimen radiography rather than relying on mammographically guided wire localization for confirmation. Lesions in our study had to be confidently identified on sonography with visualization of microcalcifications to undergo biopsy with sonographic guidance.

Another factor likely contributing to the lower detection rate was the small size (often ≤ 5 mm) and faint appearance of the clusters of microcalcifications not detected on sonography. Biopsies for these lesions proved to be challenging procedures even using the stereotactically guided technique because six stereotactically guided procedures were attempted but terminated as a result of lesions being too faint to be seen on the digital monitor.

In conclusion, suspicious clustered microcalcifications are infrequently seen on sonography. Sonography is most successful at showing larger areas of highly suspicious microcalcifications, and a positive sonogram in the setting of mammographically suspicious microcalcifications has a high specificity and a high positive predictive value for detecting

carcinoma. Biopsy of suspicious microcalcifications under sonographic guidance is a viable and accurate alternative to stereotactic biopsy for microcalcifications that are visible on sonography. This technique has potential

TABLE 2 Core Needle Biopsy Versus Surgical Excision Results

	Biopsy	Core Biopsy	Surgery
Sonographically guided			
1	IDC	IDC/DCIS	
2	IDC/DCIS	IDC/DCIS	
3	IDC/DCIS	IDC/DCIS	
4	IDC	IDC/DCIS	
5	IDC	IDC	
6	IDC/DCIS	IDC/DCIS	
7	IDC/DCIS	IDC/DCIS	
8	IDC	IDC	
9	IDC/DCIS	IDC/DCIS	
10	IDC/DCIS	IDC/DCIS	
11	IDC/DCIS	IDC	
12	IDC	IDC	
13	ADH ^a	DCIS	
14	DCIS	DCIS	
15	DCIS	DCIS	
Stereotactically guided			
1	ADH	Benign	
2	ADH	Benign	
3	DCIS	DCIS	
4	DCIS ^a	IDC/DCIS	
5	ADH	LCIS	
6	IDC/DCIS	IDC/DCIS	
7	DCIS	DCIS	
8	Benign	Benign	
9	ADH ^a	DCIS	
10	DCIS ^a	IDC/DCIS	
11	IDC/DCIS	IDC/DCIS	
12	DCIS	DCIS	
13	DCIS	DCIS	
14	DCIS	DCIS	
15	DCIS ^a	IDC/DCIS	
16	DCIS	DCIS	
17	DCIS	DCIS	
18	ADH	Benign	
19	DCIS	DCIS	
20	ADH ^a	DCIS	

Note.—IDC = invasive ductal carcinoma, DCIS = ductal carcinoma in situ, ADH = atypical ductal hyperplasia, LCIS = lobular carcinoma in situ.

^aIndicates underestimation of disease compared with surgical excision result.

for reducing patient discomfort, and further study is warranted to determine its potential for reducing underestimation of disease compared to stereotactic biopsy.

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The 2003 ARRS Annual Meeting will include a new issues forum on screening CT.