2001

Gray scale sonography of breast masses in adolescent girls

Keith A. Kronemer
Washington University School of Medicine in St. Louis

Kyung Rhee
Washington University School of Medicine in St. Louis

Marilyn J. Siegel
Washington University School of Medicine in St. Louis

Laura Sievert
Washington University School of Medicine in St. Louis

Charles F. Hildebolt
Washington University School of Medicine in St. Louis

Gray Scale Sonography of Breast Masses in Adolescent Girls

Keith A. Kronemer, MD, Kyung Rhee, MD, Marilyn J. Siegel, MD, Laura Sievert, MD, Charles F. Hildebolt, DDS, PhD

Objective. To assess the sonographic findings of breast masses in adolescents and the usefulness of sonographic patterns for suggesting a specific diagnosis. ***Methods.*** The sonograms and medical records of 57 girls (mean age, 15.4 years) with palpable breast masses were retrospectively reviewed. Three observers reviewed the sonograms for multiple sonographic findings. Surgery or clinical findings established diagnoses. Statistical analysis was done to determine how well sonographic findings alone and in combination agreed with final histologic diagnoses. ***Results.*** Diagnoses included cysts (n = 12), abscesses (n = 7), fibroadenomas (n = 36), a lactating adenoma (n = 1), and a phyllodes tumor (n = 1). The sonographic findings varied significantly among lesion types ($P \leq .005$). ***Conclusions.*** Our experience suggests that virtually all breast masses in a pediatric population are benign and that sonography has the ability to differentiate among cystic, inflammatory, and solid masses. Key words: sonography; breast; mass; adolescent.

Sonography has become a widely used modality for characterizing breast masses in adults as cystic or solid, and it has been shown to be highly reliable for this purpose.[1–5] Although the specificity of various sonographic patterns has been reported in breast masses in adults, similar data are lacking in pediatric patients. Previous series have included small numbers of children[6] or were primarily performed with older technology.[7] In view of the advances in technology and the development of high-frequency transducers, a reevaluation of the role of sonography in the clinical evaluation of the pediatric breast is appropriate. We thus undertook this study to determine whether there are gray scale sonographic findings that are helpful in differentiating breast masses in adolescents.

Received October 30, 2000, from the Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis, Missouri. Revision requested December 6, 2000. Revised manuscript accepted for publication December 21, 2000.

Address correspondence and reprint requests to Keith A. Kronemer, MD, Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, St Louis, MO 63110.

Materials and Methods

Patient Population

We retrospectively reviewed the sonograms of 170 girls younger than 19 years who were referred between January 1992 and June 1999 for evaluation of palpable breast masses. Fifty-seven patients had clinical, surgical, or pathologic evidence of breast masses and constituted the population for this study. These patients ranged in age from 11.3 to 18.9 years (mean, 15.4 years).

Sonographic Imaging Techniques

The sonographic examinations were performed with a 7.5- or 10-MHz linear phased array transducer and a commercially available scanner (Acuson Corporation, Mountain View, CA). The patients were examined in the supine position. Transverse and longitudinal real-time images were obtained through the area of the suspected mass. All examinations were performed by dedicated sonographers experienced in breast sonography and were supervised by board-certified radiologists.

Sonographic Analysis

The hard copy images were analyzed retrospectively by 3 radiologists experienced in sonography who were not involved in the performance of the original examinations. They were aware that the patients were being evaluated for possible breast masses, but they were unaware of other clinical history and results of biopsy or aspiration. The sonograms were reviewed independently. If there was a discrepancy in interpretation, a consensus reading was performed. Data were entered on a standardized form that was developed for the study.

The following sonographic features of each mass were evaluated: shape (round, oval, or irregular), margins (poorly defined or circumscribed), internal echo texture (homogeneous or heterogeneous), echo strength (anechoic, hypoechoic, or isoechoic), posterior enhancement (present or absent), and the presence of calcifications. The lesion was classified as anechoic when there were no internal echoes, as hypoechoic when low-level echoes were distinctly identifiable, and as isoechoic when the echogenicity was similar to that of adjacent tissue.

The medical records were reviewed to obtain the final diagnoses. The final diagnoses were established by surgical and histopathologic examinations in 47 patients. In the other 10 patients, the diagnoses were based on clinical follow-up or results of subsequent sonographic examinations. Two patients had 3 cysts each. The cysts in these patients had identical sonographic characteristics; therefore, only a single cyst per patient for these 2 patients was entered into the analyses to prevent artificial inflation of the sample size. The largest cyst in each patient was selected.

Statistical Analysis

A cross-tabulation table and a frequency table of lesion types and sonographic characteristics were constructed. Each sonographic characteristic was analyzed to determine how well it distinguished among the lesion types. Because many of the cells for these analyses had low frequencies, exact P values for Fisher exact tests were calculated. Statistical analyses were performed with JMP software (SAS Institute Inc, Cary, NC) and StatXact 4 (Cytel Software Corporation, Cambridge, MA).

Results

For purposes of analysis, each lesion was assigned to one of the following types: simple cyst, abscess, or solid mass.

The cross-tabulation of the sonographic characteristics and lesion types is given in Table 1. No calcification occurred in any lesion. All of the other sonographic image characteristics varied significantly among lesion types ($P \leq .005$). The statistical significance of this variation among lesion types was mostly attributable to inflammatory masses more often having irregular shapes, poorly defined borders, and heterogeneous echo textures and to simple cysts more often appearing anechoic and having fewer occurrences of unaffected signal transmission.

Twelve patients had simple cysts (age range, 9–18 years; mean, 14 years). The diagnoses were established by biopsy in 2 patients and by clinical and sonographic follow-up in 10 patients. All cysts (12 of 12) had homogeneous echo textures, anechoic contents, and enhanced transmission. Ten of 12 cysts had an oval shape, and 11 of 12 had circumscribed margins (Fig. 1).

Seven patients had breast abscesses (age range, 12–18 years; mean, 15 years). Percutaneous aspiration or surgical drainage proved the final diagnoses. The common findings in breast abscesses

were enhanced transmission in 7 of 7, hypoechoic contents in 6 of 7, and internal heterogeneity in 6 of 7. The walls were poorly defined in 4 of 7 and irregular in 4 of 7 (Fig. 2).

Solid masses occurred in 38 patients (age range, 11–18 years; mean, 16 years). Biopsy showed fibroadenomas in 36 patients, a lactating adenoma in 1 patient, and a phyllodes tumor in 1 patient. The common findings in fibroadenomas and the lactating adenoma were an oval shape in 32 of 37, well-circumscribed margins in 37 of 37, a homogeneous matrix in 36 of 37, and hypoechoic internal contents in 34 of 37 (Figs. 3 and 4). Five lesions were round, and 1 had an irregular shape. Two were heterogeneous and contained fluid-filled central clefts (Fig. 5). Three were anechoic, and 1 was isoechoic. The isoechoic lesion was identified because it produced lateral shadowing. The phyllodes tumor had an oval shape, a heterogeneous echo texture, and enhancement similar to some of the fibroadenomas, but it also had peripheral round, fluid-filled spaces (Fig. 6).

Table 1. Cross-Tabulation of Sonographic Characteristics and Lesion Type

Characteristic	Simple Cyst	Abscess	Solid Mass
Shape (P = .003)			
Round	2	0	5
Oval	10	3	32
Irregular	0	4	1
Margins (P < .001)			
Poorly defined	1	4	0
Circumscribed	11	3	38
Echo texture (P < .001)			
Homogeneous	12	1	36
Heterogeneous	0	6	2
Echogenicity (P < .001)			
Anechoic	12	1	3
Hypoechoic	0	6	34
Isoechoic	0	0	1
Posterior enhancement (P = .005)			
Absent	0	0	14
Present	12	7	24
Calcifications (P = 1.000)			
Absent	12	7	38

*Final diagnoses: fibroadenomas (n = 36), lactating adenoma (n = 1), and phyllodes tumor (n = 1).

Discussion

In our series, 57 (34%) of 170 patients with clinically suggested breast masses had pathologic lesions. This relatively high frequency makes it important for the radiologist to understand the differential diagnoses of breast lesions in children and the sonographic findings that are most helpful in discriminating among cystic, inflammatory, and neoplastic lesions.

As might be expected, the majority of breast masses in children and adolescents are benign lesions. In our series, 63% (36 of 57) of breast masses were fibroadenomas. Our findings are similar to the 50% to 75% frequency that has been reported in the pediatric surgical and pathologic literature.[8,9] In the adult population, fibroadenomas are also the most common palpable masses in women younger than 35 years.[10–13] On gross pathologic specimens, fibroadenomas are well-circumscribed lesions that usually have a round or oval shape. Histologically, they contain fibroepithelial elements with the fibrous stroma predominating. The lactating adenoma is rare in the pediatric age group, but it resembles a fibroadenoma histologically and clinically except for the fact that it has a predominance of epithelial elements. Most fibroadenomas are slow growing and reach a size

Figure 1. Simple cyst in a 15-year-old girl with a nontender right breast mass. Transverse sonogram shows characteristic features of simple cysts: an oval lesion, well-defined margins, no internal echoes, and posterior enhancement. The lesion measured 1.3 × 0.9 cm (calipers).

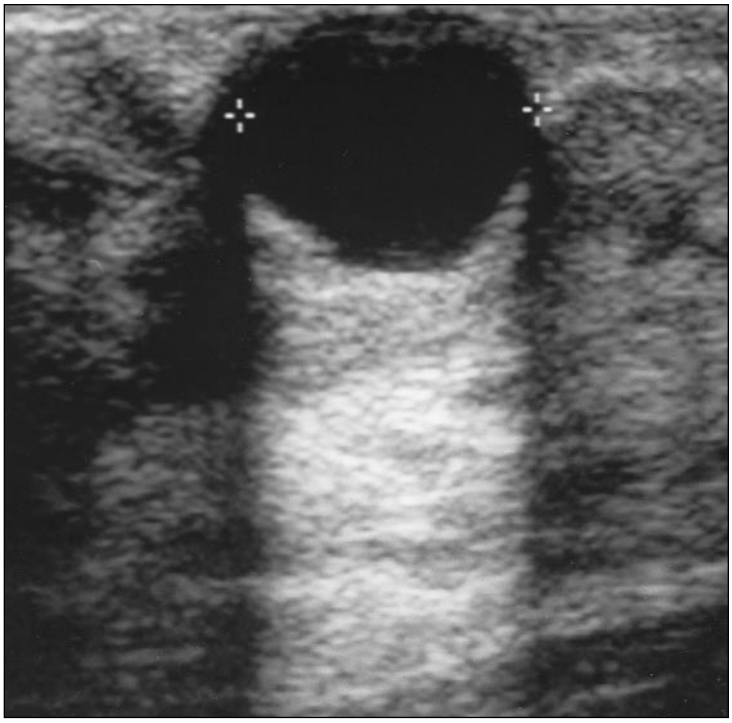
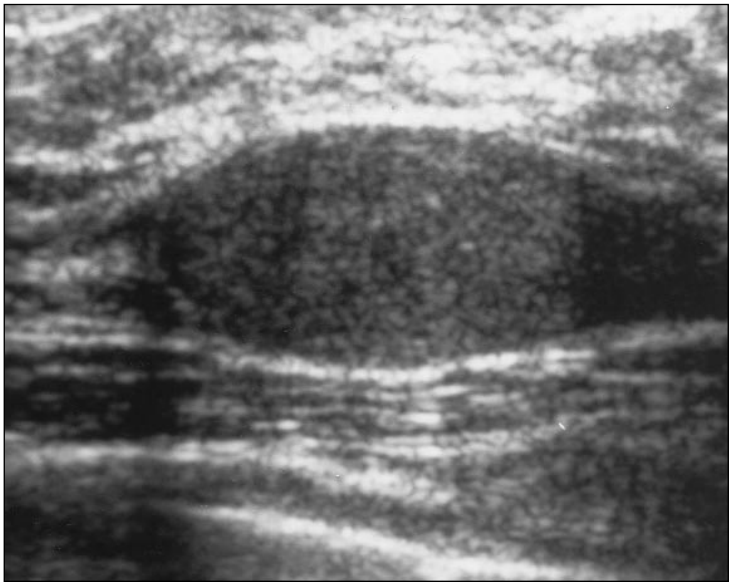


Figure 2. Abscess in a 15-year-old girl with a tender mass in the lateral right breast. Transverse sonogram shows a 1.2 × 1.9-cm hypoechoic mass with slightly lobulated margins, a fluid-debris level, and posterior acoustic enhancement.

Figure 3. Typical fibroadenoma in a 17-year-old girl with an enlarging breast mass. Transverse view of the left breast shows a 1.1 × 2.5-cm oval, smoothly marginated, hypoechoic lesion with homogeneous, low-level internal echoes and mild acoustic enhancement centrally. Histologic sections showed a circumscribed, firm mass composed of fibrous and epithelial elements.



of 2.0 to 3.0 cm in diameter.[5,10] Symptoms are minimal unless the growth is rapid or infarction occurs.

The typical sonographic features of fibroadenomas are a smooth or round lesion with homogeneous, hypoechoic internal echoes.[10–12] Approximately 63% (36 of 57) of patients in this series had this combination of findings. By comparison, in series of adult women, approximately 15% to 55% of lesions fulfilled the classic sonographic criteria for fibroadenoma.[11–13] Three fibroadenomas in our study population were anechoic relative to glandular tissue and resembled simple cysts. This may be due to large amounts of epithelial tissue in these tumors. The use of a low-gain or low-power setting is another possible cause for the absence of internal echoes. Two fibroadenomas appeared sonographically heterogeneous and were heterogeneous on pathologic specimens, with areas of necrosis or fluid-filled clefts. In this series, posterior acoustic enhancement had low discriminating power between fibroadenomas and other lesions.

Phyllodes tumor is an extremely rare breast tumor in children, accounting for less than 3% of all breast masses. The histologic hallmarks are marked stromal cellularity, mitoses, and deep clefts. The carcinomatous component usually has features of low-grade spindle cell sarcoma.[8] In our series, the phyllodes tumor had many features identical to an atypical fibroadenoma, including an oval shape, a circumscribed margin, a heterogeneous echo texture, hypoechoic echogenicity, and posterior acoustic enhancement. However, the phyllodes tumor also had peripheral cysts. This finding is similar to that reported by Buchberger et al[14] in a series of adult women with phyllodes tumors. The presence of this appearance is an indication for biopsy.

Cystic lesions were the second most common breast lesions in this series, accounting for 21% (12 of 57) of all masses. Several authors have reported that the accuracy of sonography for the diagnosis of uncomplicated breast cysts in adults is nearly 100% if strict criteria are met.[4,13] These criteria include a round or an oval shape, sharp, well-circumscribed margins, an anechoic matrix, and posterior sound transmission. Cystic lesions in children are usually solitary and lined with simple columnar or cuboid epithelium.[15] It should be noted, however, that an anechoic matrix is not specific for fluid. As observed in our population,

Figure 4. Lactating adenoma in a 17-year-old postpartum girl with a palpable nontender right breast mass. Transverse sonogram shows a 3.4 × 1.4-cm well-defined, oval, solid mass (arrowheads) with a homogeneous, hypoechoic echo texture and absence of acoustic enhancement. This appearance is similar to that of a fibroadenoma. Histologic sections showed proliferating, prominent secretory lobules with minimal stromal components.

Figure 5. Fibroadenoma in a 15-year-old girl with a painful enlarging left breast mass. Longitudinal section shows a large, 4.5 × 2.0-cm, well-circumscribed, hypoechoic mass with a heterogeneous echo texture containing thin, fluid-filled clefts and acoustic enhancement. A pathologic section showed stromal hypercellularity, myxoid changes, and necrosis.

some patients with classic findings of fluid-filled lesions had fibroadenomas or abscesses. Posterior acoustic enhancement was typical of simple cysts in this series, but it also was not specific for the diagnosis. Although all cysts in this series had posterior acoustic enhancement, 23 (64%) of 36 fibroadenomas and 7 (100%) of 7 inflammatory lesions had similar findings. Conversely, posterior enhancement may be absent in approximately 15% of cysts if they are deeply located, as a result of acoustic attenuation by adjacent muscle and cartilage.[2,5]

Abscesses accounted for 12% (7 of 57) of the lesions. Abscess formation is usually a complication of suppurative mastitis. *Staphylococcus aureus* is the most common causative organism, although gram-negative bacteria and mycobacterium have been reported.[8] Our findings show that a focal hypoechoic mass with through sound transmission, poorly defined irregular walls, and internal heterogeneity is highly suggestive of an inflammatory lesion. The findings are similar to those found by Hayes et al[16] in adults. Although not present in our series, other complex lesions, such as a posttraumatic hematoma or galactocele, can have similar appearances. Correlation with clinical history and sonographically guided aspiration of the lesion can help confirm the correct diagnosis.

The limitations of our study include the small numbers of patients with cystic and inflammatory lesions. We also lacked pathologic proof in a number of patients with cysts. Third, the absence of pathologic proof in cases with negative sonographic findings raises the possibility of false-negative diagnoses. For example, in fatty breasts, hypoechoic fibroadenomas may be mistaken for normal glandular tissue, particularly if lateral shadowing is absent.[13] Finally, very experienced operators performed the sonography; therefore, this setting may not be representative of all radiology practices.

The important question addressed by this study was whether there are sonographic variables that are useful in the diagnosis of breast disease in a pediatric population. The results of

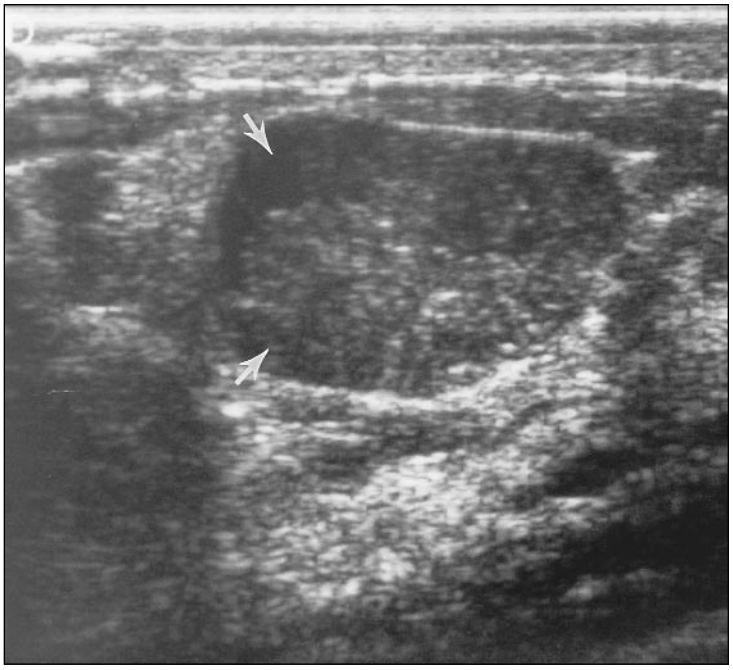


Figure 6. Phyllodes tumor in an 18-year-old girl. Transverse sonogram shows a 2.5 × 1.5-cm oval, sharply defined, hypoechoic mass with a heterogeneous echo texture and posterior enhancement. Note the small, anechoic cystic spaces peripherally (arrows).

our study support the ability of sonography to differentiate among most cystic, inflammatory, and solid masses. However, overlap in diagnoses occurs, and correlation with clinical findings cannot be ignored.

References

1. Bassett LW, Kimme-Smith C. Breast sonography: technique, equipment, and normal anatomy. Semin Ultrasound CT MR 1989; 10:82–89.
2. Hilton SVW, Leopold GR, Olson LK, et al. Real-time breast sonography: application in 300 consecutive patients. AJR Am J Roentgenol 1986; 147:479–486.
3. Jackson VP. The role of US in breast imaging. Radiology 1990; 177:305–311.
4. Piccoli CW, Wilkes AN. Breast. In: McGahan JP, Goldberg BB (eds). Diagnostic Ultrasound: A Logical Approach. Philadelphia, PA: Lippincott-Raven; 1998:1047–1062.
5. Venta LA, Dudiak CM, Salomon CG, et al. Sonographic evaluation of the breast. Radiographics 1994; 14:29–50.
6. Boothroyd A, Carty H. Breast masses in childhood and adolescence. A presentation of 17 cases and a review of the literature. Pediatr Radiol 1994; 24:81–84.
7. Harper AP, Kelly-Fry E, Noe S. Ultrasound breast imaging—the method of choice for examining the young patient. Ultrasound Med Biol 1981; 7: 231–237.
8. Coffin CM, Dehner LP. The breast. In: Stocker JT, Dehner LP (eds). Pediatric Pathology. Philadelphia, PA: JB Lippincott; 1992: 927–939.
9. West KW, Rescorla FJ, Scherer LR, et al. Diagnosis and treatment of symptomatic breast masses in the pediatric population. J Pediatr Surg 1995; 30: 182–187.
10. Cole-Beuglet C, Soriano RZ, Kurtz AB, et al. Fibroadenoma of the breast: sonomammography correlated with pathology in 122 patients. AJR Am J Roentgenol 1983; 140:369–375.
11. Fornage BD, Lorigan JG, Andry E. Fibroadenoma of the breast: sonographic appearance. Radiology 1989; 172:671–675.
12. Heywang SH, Lipsit ER, Glassman LM, et al. Specificity of ultrasonography in the diagnosis of benign breast masses. J Ultrasound Med 1985; 3:453–461.
13. Jackson VP, Rothschild PA, Kreipke DL, et al. The spectrum of sonographic findings of fibroadenoma of the breast. Invest Radiol 1986; 21:34–40.
14. Buchberger W, Straser K, Heim K, et al. Phylloides tumor: findings on mammography, sonography, and aspiration cytology in 10 cases. AJR Am J Roentgenol 1991; 157:715–719.
15. Stocker J, Dehner L (eds). Pediatric Pathology. Philadelphia, PA: JB Lippincott; 1992:927.
16. Hayes R, Mitchell M, Nunnerley HB. Acute inflammation of the breast—the role of breast ultrasound in diagnosis and management. Clin Radiol 1991; 44:253–256.