ORIGINAL ARTICLE

Pseudoangiomatous Stromal Hyperplasia of the Breast: Sonographic Features with Histopathologic Correlation

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Abstract: The objective of this study was to evaluate the spectrum of sonographic findings in pseudoangiomatous stromal hyperplasia (PASH) of the breast when it presents as a tumoral mass with pathologic correlation. Breast sonogram studies of 13 patients with 13 pathologically proven PASH lesions were retrospectively reviewed. The morphologic characteristics of the lesions as seen on ultrasound were evaluated and correlated with histopathologic findings. Sonography demonstrated most lesions, 11 of 13, to be hypoechoic in echotexture. One lesion was isoechoic in echotexture, also demonstrating small internal cysts, and one was predominantly hyperechoic. Two of the 11 hypoechoic lesions also demonstrated a complex heterogeneous pattern with a central hypoechoic area and a peripheral echogenic rim. All lesions were oval in shape with the long axis of the lesion parallel to the chest wall. None of the lesions demonstrated posterior acoustic shadowing. PASH lesions of the breast have a varied sonographic appearance. Knowledge of the spectrum of morphologic features shown on sonography can be helpful in the diagnosis of this entity.

Key Words: breast, pseudoangiomatous stromal hyperplasia, ultrasound

Pseudoangiomatous stromal hyperplasia (PASH) has been described as a benign proliferation of stromal cells with an underlying hormonal basis (1–3). Tumoral PASH may present clinically as a palpable mass or as a mammographically visible lesion, leading to sonographic evaluation. Although the mammographic and pathologic aspects of these lesions have been previously reported, to the best of our knowledge, few reports have been published on the sonographic features of tumoral PASH (4–6). The purpose of our study was to describe the spectrum of sonographic findings of this form of PASH and to correlate these features with histopathologic findings.

MATERIALS AND METHODS

Thirteen patients with the tumoral form of PASH were identified from the pathology and radiology databases of two institutions. Seven patients were identified from the first institution over the period 1997–1999. The remaining six patients were identified from the second institution over the period 1999–2001. The history, physical examination, and imaging findings (sonographic and mammographic, when available) were analyzed for all patients. Patients ranged in age from 15 to 72 years old (mean 43 years).

All patients underwent sonographic evaluation using a 7.5 MHz or a 10 MHz linear array transducer (Sequoia 512, Sonoline Elegra; Siemens, Issaquah, WA). The sonographic images were retrospectively reviewed in consensus by two radiologists with expertise in breast imaging (C.L.M., S.A.N.). The lesions were evaluated for size and were characterized according to Stavros’s sonographic criteria for breast lesions (7). Features evaluated included lesion shape, border characteristics, echogenicity, uniformity of echotexture, and presence or absence of posterior acoustic enhancement or shadowing. When available, mammograms were reviewed and evaluated for the presence of asymmetric or developing densities, architectural distortion, calcifications, and masses with and without calcifications, as characterized according to the Breast Imaging Reporting and Data System (BI-RADS) lexicon (8).

Nine of 13 patients underwent open surgical biopsy. In four patients, sampling was achieved by percutaneous
core biopsy with either sonographic guidance ($n = 3$) or stereotactic guidance ($n = 1$).

The pathology slides from both the percutaneous core biopsies and the surgical excisions were reviewed by one of two pathologists (S.A.F., D.H.B.) with expertise in breast pathology. In all cases, tissue was fixed in formalin and stained with hematoxylin-eosin for light microscopic examination. The diagnosis of PASH was based on the finding of characteristic histologic features. The sonographic morphology was then correlated with the histopathology. PASH was determined to be the target lesion in all cases.

In patients who had percutaneous core biopsy sampling ($n = 4$), short-term imaging follow-up was recommended every 6 months for a minimum of 2 years. The Institutional Review Board at our institution did not require approval or patient consent for retrospective review of images or data.

**RESULTS**

Eleven of 13 patients were premenopausal and 2 were postmenopausal at the time of presentation. One postmenopausal woman was on hormone replacement therapy at the time of diagnosis. Six lesions were detected initially on screening mammography and seven presented as palpable masses on physical examination. Three of seven lesions that presented as palpable masses were also identified on mammography studies. Eight of the nine masses visualized by mammography were classified as well-circumscribed nodules and one as an asymmetric density.

On sonographic examination, 9 of 13 cases of PASH had well-circumscribed borders. Of these nine, three had gentle lobulations. Four masses had ill-defined margins and none had irregular margins. The echogenicity of each was compared with that of the surrounding normal fat lobules. Eleven of 13 masses were hypoechoic (Fig. 1), 1 was isoechoic, and 1 was predominantly hyperechoic. Two of 11 hypoechoic lesions had a hyperechoic rim (Fig. 2). Seven of 13 lesions were homogeneous in echotexture and 6 demonstrated some heterogeneity in echotexture. Posterior acoustic enhancement was demonstrated in 3 of 13 cases and no enhancement was detected in 10 cases. No lesions exhibited posterior acoustic shadowing. All 13 masses were oval in shape, with their long axes parallel to the chest wall. Three of 13 PASH lesions demonstrated internal cystic components (Figs 3 and 4). The size of the lesions ranged from 0.6 to 3.8 cm (mean 1.6 cm).

PASH represented the target lesion in all specimens with histologic slides for all 13 lesions demonstrating anastomosing empty spaces in collagenous stroma. Three cases demonstrated internal cystic components histologically which correlated with the sonographic findings of the presence of small cysts within the lesion. The sonographic finding of a hypoechoic center and a hyperechoic rim in two lesions corresponded to a central area of PASH surrounded by adipose tissue histologically.

Follow-up imaging studies were available for review in 9 of 13 patients. Of three patients whose lesions were biopsied by ultrasound guidance, two had follow-up
imaging that did not demonstrate change in lesion appearance. Follow-up imaging for seven of nine patients who underwent excisional biopsy and one patient who underwent stereotactic-guided core needle biopsy with complete removal of the lesion demonstrated no evidence of recurrence. Follow-up studies were not available for the remaining 4 patients.

**DISCUSSION**

Pseudoangiomatous stromal hyperplasia is a benign proliferation of stromal cells composed of myofibroblasts (1,3). It has been shown to be associated with several benign entities, including proliferative and nonproliferative fibrocystic changes, fibroadenomas, gynecomastia, normal breast tissue, and sclerosing lobular hyperplasia (3,9). Microscopic PASH is a common histologic entity encountered in breast biopsies as an incidental finding. Less commonly, PASH can present as a clinically palpable mass. The etiology of this tumoral form is unknown. Rosen (1) postulated that the tumoral form of PASH is an exaggerated version of normal physiologic events. An underlying hormonal basis has been established by several authors (2,3,10–12). Vuitch et al. (2) were the first to report a resemblance between the histologic appearance of PASH and breast stroma in the luteal and secretory phases of the menstrual cycle. Subsequently Anderson et al. (10) reported that the stromal cells found in PASH expressed progesterone receptors to a greater extent than those found in normal mammary stroma.

In view of this hormonal link, it is not surprising that tumoral PASH is typically encountered in premenopausal...
women. In our study, nearly all the women were premenopausal at the time of the diagnosis. Only two women were postmenopausal when the lesions were identified on mammography studies. One of these two postmenopausal women was on hormone replacement therapy at the time, providing a hormonal stimulus.

On gross pathologic examination, tumoral PASH often presents as a well-circumscribed fibrous mass that may be white, gray or even tan in color (1,13). Occasionally cysts may be found within the lesion. Necrosis and hemorrhage are not common features except in lesions that have undergone previous needle biopsy (1).

Histologically PASH is characterized by a complex network of interanastomosing spaces within densely collagenous stroma (1,2). Both perilobular and intralobular stroma may be involved by this proliferative process. The spaces found in PASH may be dilated, slit-like, or inconspicuous. These open clefts resemble vascular spaces, hence the term “pseudoangiomatous.” However, in PASH, the spaces are felt to be the result of the separation of collagen fibers (1). Occasionally PASH lesions have been misdiagnosed as angiosarcomas (1,2). However, immunohistochemical vascular markers permit distinction between these two entities (1,3). Histologically, variable amounts of proliferative epithelial hyperplasia and apocrine metaplasia can be seen. Occasionally there may be proliferation of myofibroblasts, which can produce a more cellular form of PASH (1,3).

The mammographic appearances of PASH have been previously described. Appearances include noncalcified circumscribed or partially circumscribed masses, spiculated masses, and developing densities (4–6). In our study, eight of nine cases of tumoral PASH presented as nodules and one as an asymmetric density. However, the sonographic features of tumoral PASH are less well described (4–6). Polger et al. (5) reported three of four masses to be
solid and hypoechoic, while one was heterogeneous with a small cystic component. Cohen et al. (4) reported six of seven lesions visible by sonography to be solid hypoechoic masses as well. We identified several common sono-
graphic characteristics. In our study, all of the lesions were oval in shape, with the longitudinal axis of the lesion ori-
ented parallel to the chest wall. This suggests that tumoral
PASH may be a slow-growing lesion that grows between
fascial planes rather than through them, similar to the
growth of benign entities such as fibroadenomas (14).

Although most of the lesions in our study were solid
and hypoechoic in echotexture, some were heterogeneous
in appearance. This heterogeneity may be due to inclusion
of elements other than fibrous stroma (e.g., fibrocystic
changes or adipose tissue). All of the lesions in our study
demonstrated either posterior acoustic enhancement or
lack of enhancement. However, none of the lesions dem-
onstrated posterior acoustic shadowing.

Sonography demonstrated the presence of small inter-
cal cysts in 3 of 13 lesions. In these three cases, histologic
examination revealed the presence of cysts lined by apo-
crine cells. Two lesions had a sonographic appearance of
a hypoechoic center with a hyperechoic surrounding rim.
On histopathology, both of these lesions consisted of a
central area of PASH with irregular borders surrounded
by adipose tissue, which likely accounts for the hypere-
choic rim.

Wide local excision has been the recommended treat-
ment for PASH. In some cases, recurrences have occurred
(1). In our study, follow-up imaging studies demonstrated
no interval growth in cases where the lesions were not
completely excised, and no recurrence in patients who
underwent excisional biopsies.

In conclusion, the sonographic findings of tumoral
PASH of the breast vary. Appearances range from solid
masses which may be homogeneously hypoechoic, iso-
echoic, or hyperechoic in echotexture to masses with
cystic components. Appreciation of the spectrum of
sonographic appearances of tumoral PASH is helpful in
establishing the differential diagnosis of lesions with these
sonographic findings. Since the sonographic features of
tumoral PASH are not unique, biopsy of these lesions
is necessary to exclude malignancy and close imaging
follow-up is recommended to assess for interval growth or
recurrence.

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