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Original Article

Easily recognizable sonographic patterns of ductal carcinoma *in situ* of the breast

Chia-Ling Chiang [a,b], Huei-Lung Liang [a,b], Chen-Pin Chou [a,b], Jer-Shyung Huang [a,b], Tsung-Lung Yang [a,b], Yi-Hong Chou [b,c], Huay-Ben Pan [a,b,*]

[a] *Department of Radiology, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan, ROC*
[b] *School of Medicine, National Yang-Ming University, Taipei, Taiwan, ROC*
[c] *Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*

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Abstract

Background: Ductal carcinoma *in situ* (DCIS) is a malignant proliferation of ductal epithelium confined by the basement membrane of the involved breast ducts. The aim of this study was to categorize positive findings of DCIS of the breast on sonography.
Methods: From 2007 to 2011, 100 pathologically proven DCIS lesions were evaluated. Four sonographic patterns used to identify DCIS have been characterized as cumulus-type, coral-type, pipe-type, and miscellaneous lesions.
Results: The lesion numbers of nonhigh-grade and high-grade DCIS were 44 and 56, respectively. The coral type (42%) was the most commonly found lesion, followed by cumulus-type (38%), pipe-type (17%), and miscellaneous (3%) lesions. There was no significant difference between the sonographic pattern and nuclear grades. However, the coral-type group was composed of significantly more high-grade DCIS cases than the other three types ($p < 0.05$).
Conclusion: Coral-, cumulus-, and pipe-type lesions are three easily recognizable sonographic findings of DCIS. Improving the breast ultrasound technique to better demonstrate the sonographic pattern is necessary to facilitate breast lesion interpretation.

Keywords: breast; ductal carcinoma *in situ*; sonography; ultrasound

1. Introduction

Ductal carcinoma *in situ* (DCIS) is a malignant proliferation of ductal epithelium confined by the basement membrane of the involved breast ducts. It represents a broad biological spectrum of disease and has become increasingly important not only because of the dramatic rise in detection rates, but also because of the ongoing controversy regarding its clinical importance and optimal treatment.[1,2] DCIS now accounts for as much as 30% of breast cancers in the general screening population and approximately 5% of breast carcinomas in symptomatic women.[3–6] The mammographic features of DCIS have been well-described in the literature, with microcalcifications being the dominant feature.[4,5,7,8] Other findings such as mass, nodular abnormality, architectural distortion, dilated retroareolar duct, and developing density have also been reported.[7,9] Although most cases of DCIS are diagnosed based on mammography findings, 6–23% of DCIS lesions are not visible on mammographic imaging.[5,6,9]

Breast ultrasound is an adjunctive imaging modality for detection of breast cancer with a sensitivity of up to 89%, and used as a supplemental tool to physical breast examination.[10] The sonographic findings of DCIS from recent studies include

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* Corresponding author. Dr. Huay-Ben Pan, Department of Radiology, Kaohsiung Veterans General Hospital, 386, Ta Chung 1st Road, Kaohsiung 813, Taiwan, ROC.
E-mail address: panhb@vghks.gov.tw (H.-B. Pan).

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irregular masses, mammary duct ectasia, and benign cystoids.[11–17] The most common sonographic findings of DCIS include a microlobulated mass with mild hypoechogenicity, ductal extension, and normal acoustic transmission or a cystic or solid mass with circumscribed margin, followed by hypoechoic mass with indistinct margin or intraductal lesion.[11,14] Based on the mass itself, Izumori et al[11] stated that it is difficult to differentiate DCIS from benign lesion. Current studies also suggest that low- and high-grade DCIS follow different genetic routes,[18,19] and the predominant nuclear grade is the best predictor of local recurrence.[20] The sonographic features of irregular-shaped mass with indistinct or angular margins and no posterior acoustic shadowing or enhancement were reported to be associated with a high-grade lesion,[13] whereas Park et al[21] reported that no significant difference was seen in the sonographic features of masses between high-grade and nonhigh-grade DCIS except that microcalcifications were more common in high-grade lesions (43.2% vs. 3.1%).

The purpose of this study was to retrospectively (1) categorize the sonographic features of 100 DCIS lesions, and (2) to evaluate the possibility of differentiating between high-grade and nonhigh-grade DCIS lesions by ultrasound.

2. Methods

2.1. Patients

From November 2007 to December 2011, 96 women with pathologically proven DCIS lesions ($n = 100$) were enrolled in this study. These patients had received preoperative mammography and sonography, and breast ultrasound was performed for the following reasons: (1) as a supplemental examination of suspicious lesions on screening mammography, (2) as a preoperative survey to identify whether the lesion is multifocal or contralateral, or (3) as a diagnostic study for symptomatic patients. The sonographic images and relevant clinical data were reviewed and analyzed with consensus by three radiologists with 6 years, 10 years, and 25 years of experience, respectively, in interpreting breast images. Of the 96 patients, four had DCIS in bilateral breasts. Microinvasion, defined as the extension of cancer cells beyond the basement membrane into the adjacent tissues with no focus more than 0.1 cm in diameter,[22] was included in this study as in previous series.[13,14,23] Patients initially diagnosed as a case of DCIS by needle biopsy but which ultimately turned out to be invasive carcinoma in gross specimen examination were excluded. The time interval between the breast ultrasound examination and biopsy, lumpectomy, or mastectomy was less than 6 months. We retrospectively reviewed these images to document the spectrum of sonographic features of DCIS lesions and to further correlate these features with histopathologic nuclear grading. The nuclear grade was divided into high grade and nonhigh grade, and the latter included intermediate grade and low grade. This retrospective review was approved by the Institutional Review Board of our institute, and the requirement for individual patient's informed consent was waived.

2.2. Breast sonography

Whole-breast sonography was performed using a high-resolution 10-MHz linear array transducer on a LOGIQ 9 US unit (General Electric Medical Systems, Milwaukee, WI, USA) or a SuperSonic Aixplorer US unit (SuperSonic Imaging, Aix-en-Provence, France) with the ipsilateral arm raised above the patient's head. A systematic evaluation of the whole breast using radial and antiradial scanning techniques in a clockwise fashion in the plane of the ductal system was routinely performed.[18] In patients with DCIS, radial ultrasound is particularly useful in depicting intraductal masses and evaluating the ductal extent of the disease, whereas antiradial ultrasound is more helpful for evaluating the surface characteristics of the mass. Before the sonographic examinations, the radiologists were aware of the patients' mammographic results. Sonograms were reviewed for masses, architectural distortion, ductal extension and dilatation, and microcalcifications. For mass lesions, the size, nature (solid or cystic), shape, margin, echogenicity, and posterior acoustic phenomena were recorded. The positive sonographic features were categorized into four patterns (Fig. 1): (1) coral type, which is an intraductal soft-tissue mass growing along the ducts just like a branching stony coral on the radial images (Fig. 2); (2) cumulus type, which has fuzzy and uneven margins like cumulus clouds on the antiradial views (Fig. 3); (3) pipe type, which is a mass located upstream with its prominent preexisting supporting lactiferous duct toward the nipple—the hollow cylinder plus upstream mass appear just like a pipe on scanning images (Fig. 4); (4) miscellaneous type, which are lesions not fitting with any of the aforementioned types (Fig. 5).

2.3. Statistical analysis

All sonographic features and specific patterns were compared with the histopathologic findings. To determine whether there was any difference in the sonographic features, specific sonographic patterns, and histopathologic nuclear grades of DCIS, Chi-square test was performed using a statistical software system (SPSS for Windows version 12.0; SPSS Inc., Chicago, IL, USA). Findings with $p < 0.05$ were considered statistically significant.

3. Results

The mean age of the 96 patients (100 DCIS lesions) was 48 years (range 32–68 years). There were 44 lesions of nonhigh grade (including 18 lesions of low grade and 26 lesions of intermediate grade) and 56 lesions of high grade, which included 11 lesions associated with microinvasion.

The correlation between sonographic features and histopathologic findings of the 100 sonographically visible DCIS lesions is presented in Table 1. The most common sonographic feature of DCIS was solid type ($n = 96$, 96%), followed by hypoechogenicity ($n = 86$, 86%), and normal posterior