Available online at www.sciencedirect.com
ScienceDirect
Journal of the Chinese Medical Association 79 (2016) 493–499
www.jcma-online.com

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*

Received May 29, 2014; accepted May 24, 2016

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

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

* 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).

http://dx.doi.org/10.1016/j.jcma.2016.03.009

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

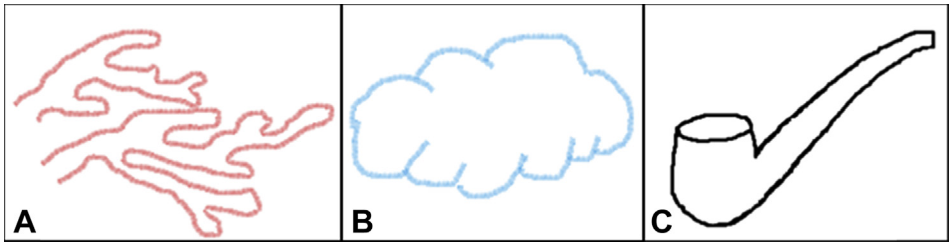

Fig. 1. Simple cartoon figures of three easily recognizable sonographic patterns of ductal carcinoma *in situ*. (A) Coral type is characterized by angular or irregular shape with ductal extension and dilatation. (B) Cumulus type is usually nonspecific with ovoid or lobular shape. (C) Pipe type is characterized by a hypoechoic nodular lesion with a dilated lactiferous duct leading to the retroareolar region.

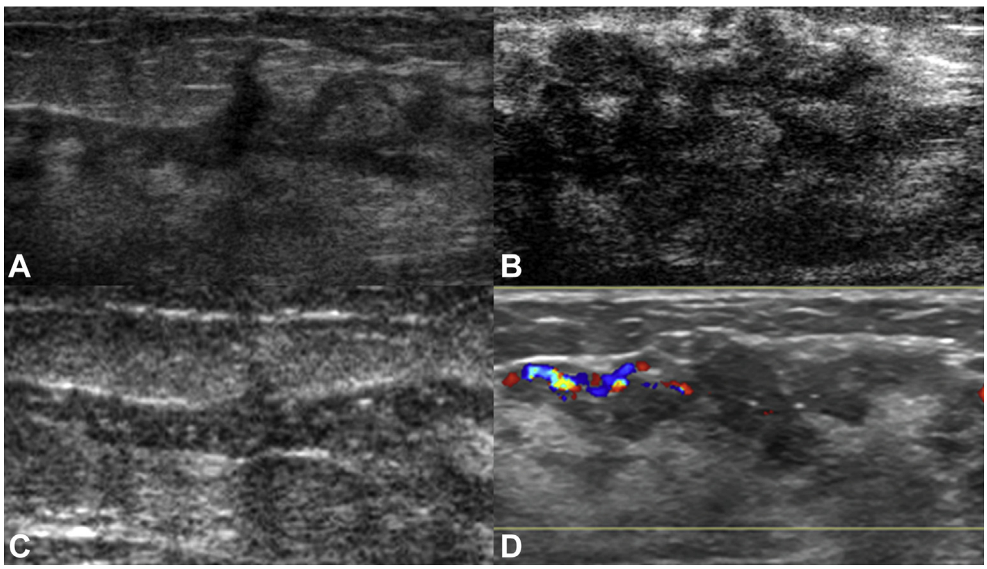

Fig. 2. Coral type: a lesion that presents as a wind duct dilatation with inhomogeneous hypoechoic tumor growth along the preexisting framework of breast ducts. The appearance is just like a branching stony coral. (A) Intermediate-grade ductal carcinoma *in situ* (DCIS) presented as an irregular-shaped, branching, finger-like lesion; (B) high-grade DCIS with microinvasion presented as an irregular-shaped inhomogeneous lesion with angular margin, branching, dilated and extended ducts; (C) high-grade DCIS manifested as a dilated lactiferous duct with multiple intraductal microcalcifications; and (D) color Doppler ultrasound of a high-grade DCIS lesion well revealed hypervascularity in the tumor.

acoustic transmission (n = 80, 80%). The most frequent sonographic manifestation of DCIS in the study was a hypoechoic solid lesion with irregular shape, indistinct or angular margin, and normal acoustic transmission; particularly, more than half of the cases showed microcalcifications (n = 63, 63%). Microcalcifications were characteristically detected within a mass or duct because they were usually not visible without a hypoechoic background. Most lesions demonstrated normal acoustic transmission (n = 80, 80%) except five cases with posterior enhancement and 15 cases with posterior attenuation. Radial scanning sonograms demonstrated associated ductal change and tumor extending courses, including ductal dilatation with or without extension to the retroareolar area in 59 (59%) of DCIS cases. Most of the sonographic features did not show a significant correlation between different nuclear grades with the only exception that intralesional vascularity was significantly more frequently present in high-grade lesions. However, Doppler color images were only recorded in 36 (36%) cases, and therefore, the significance interpretation was limited.

With regard to the sonographic patterns, the most common pattern was the coral type (42%), followed by the cumulus (38%) and pipe (17%) types. In the other three cases classified as the miscellaneous type (3%), two were complex cystic lesions with circumscribed border and irregular mural nodules, and the last one contained mixed cystic and solid components. The correlation of different sonographic patterns, nuclear grading, and the presence of microcalcifications or internal color flow is provided in Table 2. There was no statistically significant difference between the sonographic patterns and the histological nuclear grading. Microcalcifications and internal vascularity were significantly more frequently detected in coral-type lesions than other types ($p < 0.05$). The majority of DCIS in our series presented with normal posterior acoustic transmission, except for five cases manifesting posterior enhancement, including two low-grade lesions, one intermediate-grade lesion, and two high-grade lesions; another 15 cases manifested posterior acoustic attenuation, of which two cases were intermediate grade and 13 cases were high-grade lesions. According to sonographic patterns, in the five cases with posterior enhancement, three presented as cumulus-type lesions and two presented as cystic lesions; in the 15 cases with posterior shadowing, eight were coral type, four were pipe type, and three were cumulus type; 11 cases were

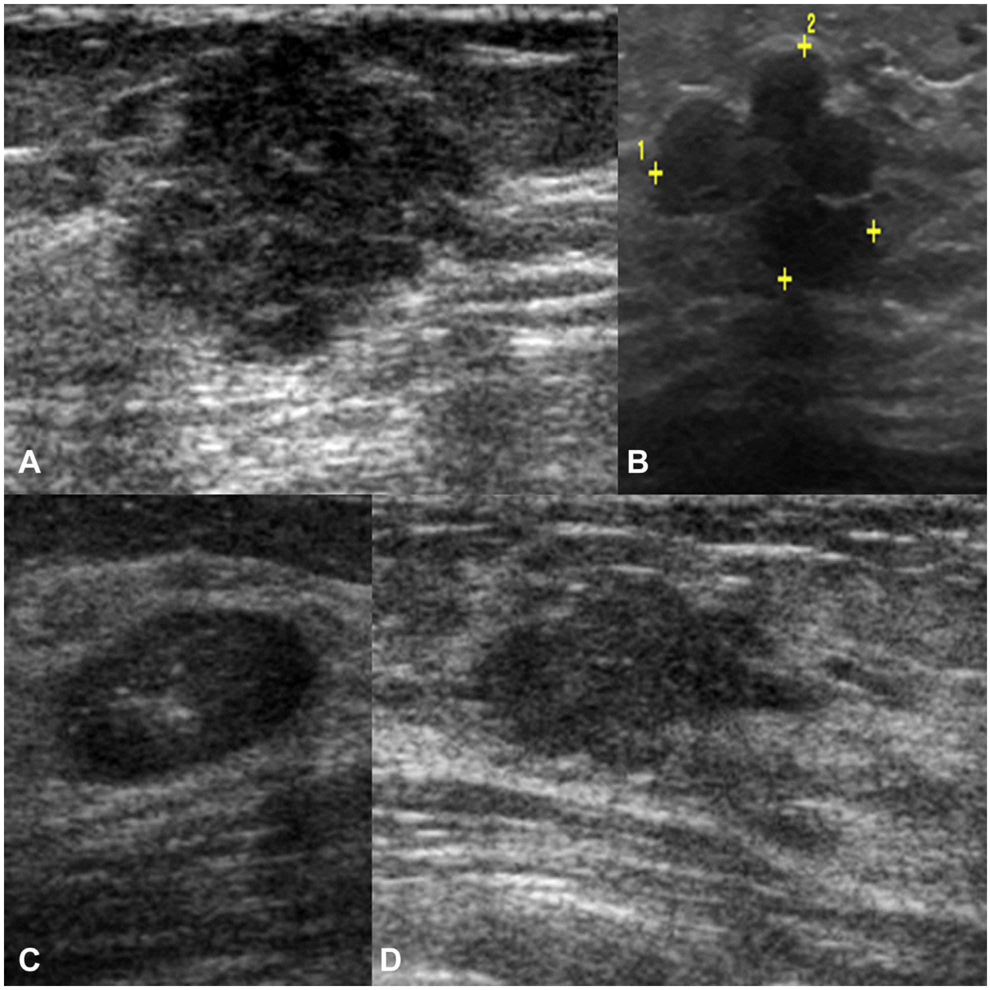

Fig. 3. Cumulus type: inhomogeneous hypoechoic lesion with oval or irregular shape and with indistinct or microlobulated margin. Most lesions demonstrate normal posterior acoustic transmission. The appearance is just like a cumulus cloud. (A) A high-grade ductal carcinoma *in situ* (DCIS) with comedo manifested as an irregular solid mass with microlobulated border and posterior acoustic enhancement; (B) intermediate-grade DCIS demonstrated as a lobular-shaped solid mass; (C) low-grade DCIS lesion presented as an ovoid mass with largely circumscribed border and internal microcalcifications; and (D) intermediate-grade DCIS showed irregular-shaped, indistinct margin and some intratumoral microcalcifications on ultrasound.

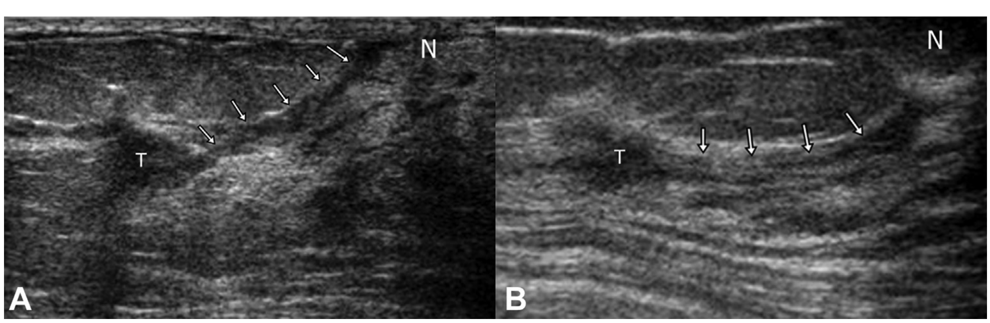

Fig. 4. Pipe type: an inhomogeneous hypoechoic lesion located upstream of a dilated lactiferous duct leading to the nipple. The appearance is just like a pipe. (A) Breast sonogram of a high-grade ductal carcinoma *in situ* (DCIS) in the radial axis demonstrated an irregular-shaped hypoechoic lesion (T) connected to the nipple (N) by a dilated lactiferous duct (white arrows) and (B) a low-grade DCIS lesion of the pipe type showed a hypoechoic tumor (T) with a characteristic dilated lactiferous duct (white arrows) extending to the nipple (N).

diagnosed as microinvasive DCIS, all belonging to high nuclear grade, with seven cases manifesting coral-type and four cases manifesting cumulus-type lesions.

Pipe-type DCIS lesions tended to be located closer to the areolar area compared with the other two types. The percentage of lesions located less than 3 cm away from the nipple

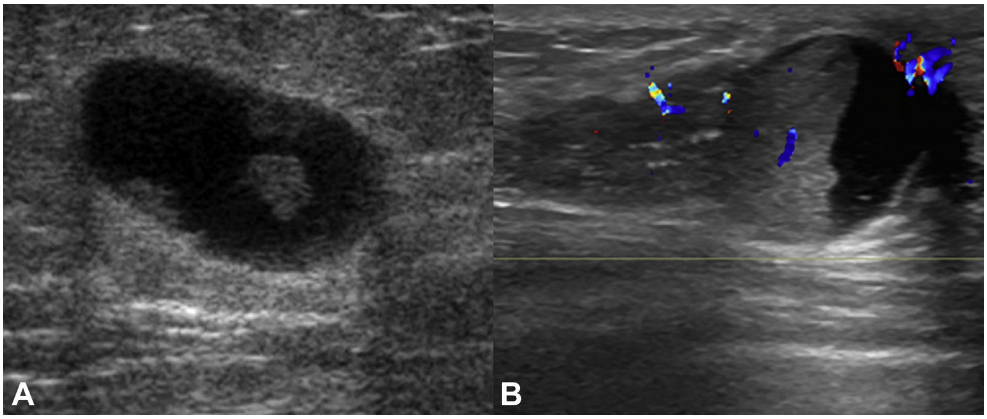

Fig. 5. Miscellaneous type: lesions with sonographic features not fitting the other three patterns. (A) A low-grade ductal carcinoma *in situ* (DCIS) lesion presented as an ovoid cystic lesion with small mural polypoid nodules and posterior acoustic enhancement and (B) a high-grade DCIS lesion contained cystic component and conspicuous solid tumor, which demonstrated internal hypervascularity on color Doppler ultrasound.

in the coral, cumulus, and pipe types was 51.3%, 33.3%, and 88.2%, respectively.

4. Discussion

DCIS has been encountered more frequently because of the widespread use of mammography screening in asymptomatic women. Mammography is also the most important imaging technique for the detection of DCIS, assessment of disease extent, and the facilitation of image-guided biopsies.[13] The mammographic appearances of DCIS have been well-described in the literature, with microcalcifications (either clustered or segmented) being the dominant feature.[4,5,7,8] However, it is difficult to detect DCIS without microcalcification using mammography, especially in dense breasts, and approximately 6–23% of DCIS lesions remain undetected.[5,6,9] Approximately 60% of women with DCIS will progress to invasive ductal carcinoma (IDC) over an 8–10-year period, and poor prognostic outcomes are likely when IDC develops.[24] Traditionally, ultrasound was regarded as less useful in detecting DCIS. However, with the advances in ultrasound resolution and competent microcalcification detection, it is now regarded as an adjunctive tool to increase the sensitivity and specificity of mammography in breast diagnosis, particularly in dense breast and breast lesion without calcifications.[12,13,17,25–28]

Because DCIS is a broad-spectrum disease with a wide variety of clinical features from asymptomatic, palpable mass, and nipple discharge to Paget's disease,[14] it also presents as heterogeneous manifestations on ultrasound. In the literature, a microlobulated mass with mild hypoechogenicity, ductal extension, and normal acoustic transmission was the most common ultrasound finding in DCIS.[13,14,18] Yang and Tse[13] described the following sonographic findings of DCIS in symptomatic women: mass (72%), ductal change (23%), and architectural distortion (7%). In addition, an ultrasound-visible, irregularly shaped mass with indistinct or angular margin, and no posterior acoustic transmission was associated with a high Van Nuys classification.[13] Vieira et al[23] further analyzed Yang and Tse's cases in conjunction with their own study, and concluded that a mass with or without calcifications was more frequently encountered in microinvasive DCIS rather than in pure DCIS, where calcification only was the more common finding.[5,6,9] By contrast, Shin et al[12] found that although sonographically visualized mass and associated ductal change were more common in symptomatic patients, associated microcalcifications and posterior shadowing were more frequently encountered in screen-detected DCIS, and there were no significant differences in pathologic features of the two groups. Our results agree with those of Shin et al[12] that suggest there was no significant difference between the sonographic features and nuclear grading. We regard the discrepancy originating from the description of sonographic features. Because DCIS is in fact a tumor growth along the preexisting framework of breast ducts, instead of conspicuous breaking of the basement membrane, we prefer the morphological description of different "patterns" rather than "mass or nonmass" lesions. Therefore, we summarized these variable feature depictions into three easily recognizable patterns.

Among the variable descriptions of sonographic features of DCIS, we proposed three easily recognizable patterns of frequently encountered sonographic findings of DCIS. The coral type depicts a solid mass with isoechogenicity or hypoechogenicity, irregular shape, angular or spiculated margin, often associated with ductal extension or architectural distortion. The cumulus type depicts a lobular solid mass with circumscribed, microlobulated, or indistinct margin, which sometimes manifests heterogeneous echogenicity due to multiple intrinsic interfaces, and the complex echotexture has also been described as a "pseudomicrocystic" appearance by some authors.[25,29,30] The pipe type consists of a solid ovoid mass with indistinct, microlobulated, angular, or spiculated margin and a connecting dilated duct leading to the retroareolar region. The coral-type pattern tends to be a more conspicuous lesion and usually needs tissue proof. In our result, coral-type lesions displayed significantly more internal vascularity, which was associated with high nuclear-grade DCIS ($p < 0.05$). In addition, microcalcifications were also

Table 1
Correlation between sonographic and histopathologic findings of 100 cases of ductal carcinoma *in situ*.

Imaging findings	Histopathologic findings		
	Nonhigh grade	High grade	*p*
Total	44	56	
Mass nature			0.395
Solid	41	55	
Cystic	2	1	
Solid and cystic	1	0	
Shape			0.333
Ovoid	8	5	
Lobular	8	8	
Irregular	28	41	
Margin			0.809
Circumscribed	3	3	
Microlobulated	6	5	
Indistinct	10	17	
Angular	19	21	
Spiculated	6	10	
Echogenicity			0.452
Hypoechoic	40	46	
Isoechoic	0	1	
Heterogeneous	4	9	
Posterior phenomena			0.091
Nil	38	42	
Enhanced	3	2	
Shadowing	3	12	
Architectural distortion	15	11	0.288
Ductal changes			0.648
None	20	21	
Dilatation	10	17	
Extension	0	0	
Dilatation and extension	14	18	
Microcalcifications			0.088
None	21	16	
Mass	12	27	
Ductal	5	3	
Mass and ductal	6	10	
Color flow			0.006
Present	15	11	
Absent	9	3	
Not performed	20	42	
Sonographic pattern			0.182
Cumulus	21	17	
Coral	14	28	
Pipe	7	10	
Miscellaneous	2	1	

significantly more often detected in the coral type. While there was no significant correlation between the presence of microcalcifications and high-grade lesion in our study, other authors found that microcalcifications were more common in high-grade than in nonhigh-grade lesions (43.2% vs. 3.1%).[21]

Table 2
Correlation of sonographic patterns and histopathological nuclear grading and presence of microcalcifications.

Sonographic patterns	Coral type	Cumulus type	Pipe type	Miscellaneous	*p*
Nonhigh grade/high grade (%/%)	14/28 (33/67)	21/17 (55/45)	7/10 (41/59)	2/1 (67/33)	0.182
Microcalcifications (%)	33 (79)	18 (48)	8 (47)	0 (0)	0.001
Color flow (%)	14/15 (93)	9/17 (53)	3/5 (60)	0/1 (0)	0.036

DCIS lesions can be located in any area inside the breast and grow along the ductal system. If the tumor breaks through the duct, then it could grow in all directions and thus was named "invasive" ductal carcinoma. Pathological change in the ductal system such as proliferation of luminal epithelial cells or myoepithelial cells will result in enlargement of the duct or wall thickening. Different cutting sections of slices will present different shapes. According to the distribution of the ductal system, if the tumor arises at the periphery, it will present as the cumulus type. If the tumor spreads along the duct, it will present as the coral type, and if it excretes or expands into the preexisting scaffold main duct, it will turn out to be the pipe type.

Knowledge of the patterns of DCIS in sonogram can provide sonographers an excellent opportunity to catch early lesions and alert clinicians to prompt biopsy with sonographic guidance, which is more cost effective and tolerable. Ultrasound has now been applied to routine screening for symptomatic women and recalled asymptomatic women with positive mammographic findings or any lesion before biopsy in our hospital. Owing to the extensive use of ultrasound, some subtle lesions that went undetected on mammography can be well-demonstrated using ultrasound, such as retroareolar, intraductal, and intracystic lesions and noncalcified mass lesions, particularly in dense breast. Once a dilated lactiferous duct is noted on ultrasound, one should "trace backward" and an upstream hypoechoic solid mass lesion may be detected. In addition, the following findings accompanied by an asymmetrically dilated duct should raise concern for possible malignancy: nonretroareolar location, interval change, or suspicious microcalcifications. It is difficult to accurately measure the tumor size of DCIS, especially in the coral and pipe types, where evaluating the extent of ductal dilatation and extension is more important and may present interoperator variations. Some have stated that there was no reliable method for routinely measuring the size of DCIS and that the size and extent of a DCIS lesion were often an estimate.[31,32] We only recorded if a lesion was more or less than 1 cm under sonography, which interferes with the reliability of the pathological result of core-needle biopsy under ultrasound guidance.

The primary limitation of this study was as a retrospective review, and that our study cases were mainly recalled screening patients with positive mammographic findings. Therefore, we were unable to review a complete picture of sonographic features of mammographically occult DCIS. Second, the number of sonographic features other than coral, cumulus, or pipe types was small, although one of the reasons was that circumscribed ovoid solid or cystic lesions were usually regarded as benign in nature and evaded biopsy or were allotted to follow-up. Lastly, there was no correlation with mammography, which was currently recognized as the standard imaging in detecting DCIS lesions. Many of our DCIS lesions were incidental findings during sonography examinations for other suspicious mammographic findings, and were not perceptible on mammography. Thus, the precise mammographic manifestation of each ultrasound-positive lesion could not be ascertained by the location-to-location correlation method. A biopsy-site marker clip and post-biopsy mammography would be necessary to precisely compare the mammographic and sonographic manifestations of one lesion, but the marker clip is a self-pay device in Taiwan and has thus not been routinely used in daily practice.

In conclusion, with advances in technology, ultrasound has become an important adjunct in breast cancer diagnosis. Among the variable descriptions of sonographic features of DCIS, we proposed three easily recognizable patterns with the coral type being the most common one, followed by the cumulus and pipe types. Improving the breast examination technique with the radial and antiradial axes to demonstrate subtle projection courses toward the nipple is necessary to make the sonographic pattern capable of being well-demonstrated and hence aid in clinical interpretation.

Acknowledgments

We would like to express our very great appreciation to our sonographers for their delicate and valuable contribution during the image acquisition to develop this research work.

References

1. Silverstein MJ, Parker R, Grotting JC, Cote RJ, Russell CA. Ductal carcinoma *in situ* (DCIS) of the breast: diagnostic and therapeutic controversies. *J Am Coll Surg* 2001;**192**:196−214.
2. Feig SA. Ductal carcinoma *in situ*. Implications for screening mammography. *Radiol Clin North Am* 2000;**38**:653−68.
3. Tabár L, Vitak B, Chen HH, Duffy SW, Yen MF, Chiang CF, et al. The Swedish Two-County Trial twenty years later. Updated mortality results and new insights from long-term follow-up. *Radiol Clin North Am* 2000;**38**:625−51.
4. Pan HB, Wong KF, Yang TL, Hsu GC, Chou CP, Huang JS, et al. The outcome of a quality-controlled mammography screening program: Experience from a population-based study in Taiwan. *J Chin Med Assoc* 2014;**77**:531−4.
5. Stomper PC, Connolly JL, Meyer JE, Harris JR. Clinically occult ductal carcinoma *in situ* detected with mammography: analysis of 100 cases with radiologic-pathologic correlation. *Radiology* 1989;**172**:235−41.
6. Dershaw DD, Abramson A, Kinne DW. Ductal carcinoma *in situ*: Mammographic findings and clinical implications. *Radiology* 1989;**170**:411−5.
7. Evans A, Pinder S, Wilson R, Sibbering M, Poller D, Elston C, et al. Ductal carcinoma *in situ* of the breast: correlation between mammographic and pathologic findings. *AJR Am J Roentgenol* 1994;**162**:1307−11.
8. Tabar L, Gad A, Parsons WC, Neeland DB. Mammographic appearances of in situ carcinomas. In: Silverstein MJ, editor. *Ductal carinoma in situ of the breast*. Baltimore, MD: Williams & Wilkins; 1997. p. 95−117.
9. Ikeda DM, Andersson I. Ductal carcinoma *in situ*: atypical mammographic appearances. *Radiology* 1989;**172**:661−6.
10. Lenz S. Breast ultrasound in office gynecology—ten years of experience. *Ultraschall Med* 2011;**32**:S3−7.
11. Izumori A, Takebe K, Sato A. Ultrasound findings and histological features of ductal carcinoma *in situ* detected by ultrasound examination alone. *Breast Cancer* 2010;**17**:136−41.
12. Shin HJ, Kim HH, Kim SM, Kwon GY, Gong G, Cho OK. Screening-detected and symptomatic ductal carcinoma *in situ*: differences in the sonographic and pathologic features. *AJR Am J Roentgenol* 2008;**190**:516−25.
13. Yang WT, Tse GM. Sonographic, mammographic, and histopathologic correlation of symptomatic ductal carcinoma *in situ*. *AJR Am J Roentgenol* 2004;**182**:101−10.
14. Moon WK, Myung JS, Lee YJ, Park IA, Noh DY, Im JG. US of ductal carcinoma *in situ*. *Radiographics* 2002;**22**:269−80.
15. Hashimoto BE, Kramer DJ, Picozzi VJ. High detection rate of breast ductal carcinoma *in situ* calcifications on mammographically directed high-resolution sonography. *J Ultrasound Med* 2001;**20**:501−8.
16. Buchberger W, Niehoff A, Obrist P, DeKoekkoek-Doll P, Dünser M. Clinically and mammographically occult breast lesions: detection and classification with high-resolution sonography. *Semin Ultrasound CT MR* 2000;**21**:325−36.
17. Buchberger W, DeKoekkoek-Doll P, Springer P, Obrist P, Dünser M. Incidental findings on sonography of the breast: clinical significance and diagnostic workup. *AJR Am J Roentgenol* 1999;**173**:921−7.
18. Sewell CW. Pathology of high-risk breast lesions and ductal carcinoma *in situ*. *Radiol Clin North Am* 2004;**42**:821−830, v.
19. Vos CB, ter Haar NT, Rosenberg C, Peterse JL, Cleton-Jansen AM, Cornelisse CJ, et al. Genetic alterations on chromosome 16 and 17 are important features of ductal carcinoma *in situ* of the breast and are associated with histologic type. *Br J Cancer* 1999;**81**:1410−8.
20. White J, Levine A, Gustafson G, Wimbish K, Ingold J, Pettinga J, et al. Outcome and prognostic factors for local recurrence in mammographically detected ductal carcinoma *in situ* of the breast treated with conservative surgery and radiation therapy. *Int J Radiat Oncol Biol Phys* 1995;**31**:791−7.
21. Park JS, Park YM, Kim EK, Kim SJ, Han SS, Lee SJ, et al. Sonographic findings of high-grade and non-high-grade ductal carcinoma *in situ* of the breast. *J Ultrasound Med* 2010;**29**:1687−97.
22. American Joint Committee on Cancer. *Cancer staging manual*. 5th ed. Berlin, Germany: Springer; 2002.
23. Vieira CC, Mercado CL, Cangiarella JF, Moy L, Toth HK, Guth AA. Microinvasive ductal carcinoma *in situ*: clinical presentation, imaging features, pathologic findings, and outcome. *Eur J Radiol* 2010;**73**:102−7.
24. Leung TK. The application of breast MRI on Asian women (dense breast pattern). In: Tabar Laszlo, editor. *Imaging of the breast: Technical aspects and clinical implication*. Rijeka, Croatia: InTech; 2012. p. 23−60 [chapter 2].
25. Wang LC, Sullivan M, Du H, Feldman MI, Mendelson EB. US appearance of ductal carcinoma *in situ*. *Radiographics* 2013;**33**:213−28.
26. Soo MS, Baker JA, Rosen EL. Sonographic detection and sonographically guided biopsy of breast microcalcifications. *AJR Am J Roentgenol* 2003;**180**:941−8.
27. Moon WK, Im JG, Koh YH, Noh DY, Park IA. US of mammographically detected clustered microcalcifications. *Radiology* 2000;**217**:849−54.
28. Kim JH, Ko ES, Kim DY, Han H, Sohn JH, Choe DH. Noncalcified ductal carcinoma *in situ*: imaging and histologic findings in 36 tumors. *J Ultrasound Med* 2009;**28**:903−10.
29. Mesurolle B, El-Khoury M, Khetani K, Abdullah N, Joseph L, Kao E. Mammographically non-calcified ductal carcinoma *in situ*: sonographic features with pathological correlation in 35 patients. *Clin Radiol* 2009;**64**:628−36.
30. Berg WA. Sonographically depicted breast clustered microcysts: Is follow-up appropriate? *AJR Am J Roentgenol* 2005;**185**:952−9.
31. Saqi A, Osborne MP, Rosenblatt R, Shin SJ, Hoda SA. Quantifying mammary duct carcinoma *in situ*: a wild-goose chase? *Am J Clin Pathol* 2000;**11**:S30−7.
32. Rosen PP. Intraductal carcinoma. In: *Rosen's breast pathology*. Philadelphia, PA: Lippincott-Raven; 1997.