Features of cystic breast lesions at ultrasound elastography*

Apresentação das lesões mamárias císticas à ultra-sonografia utilizando a elastografia

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Abstract

OBJECTIVE: To demonstrate the most frequent features of cystic breast lesions at ultrasound elastography, discussing the applicability of this method. MATERIALS AND METHODS: The present casuistic included 150 patients referred for percutaneous breast biopsy of 175 lesions. Histologically diagnosed solid lesions (153 lesions) were excluded; lesions histologically diagnosed as cystic (22 lesions), including complicated cysts, papillary lesions, inflammatory lesions, typical columnar cell hyperplasia and duct ectasia were retrospectively classified by means of elastography, according to a scoring system developed by the authors, with categories ranging between 1 and 4. RESULTS: Thirteen (59%) of the 22 lesions evaluated corresponded to cysts, one (4.6%) to duct ectasia, two (9.2%) to inflammatory lesions, five (22.6%) to papillary lesions, and one (4.6%) to columnar cell hyperplasia. The scoring system was applied with the following results: 17 category 2 lesions, four category 3 lesions, one category 4 lesion, and none category 1 lesion, with a 95% specificity. CONCLUSION: Different features of cystic breast lesions are demonstrated by elastography according to histological results, representing a useful and easily applicable method for differentiating benign from malignant breast lesions. Keywords: Breast cyst; Ultrasonography; Breast.

Resumo

OBJETIVO: Demonstrar a apresentação mais frequente das lesões mamárias císticas utilizando a elastografia e discutir a sua aplicabilidade. MATERIAIS E MÉTODOS: A casuística compôs-se de 150 pacientes encaminhadas para realização de biópsia mamária percutânea com 175 lesões. Foram excluídas as lesões com diagnóstico histológico de lesões sólidas (153 lesões) e incluídas as lesões com características císticas à histologia (22 lesões), incluindo cistos complicados, lesões papilíferas, lesões inflamatórias, hiperplasia de células colunares típica e ectasia ductal. Estas lesões foram classificadas de forma retrospectiva por meio da elastografia, conforme escores criados pelos autores, variando de 1 a 4. RESULTADOS: Das 22 lesões encaminhadas, 13 (59%) correspondiam a cistos, uma (4,6%) a ectasia ductal, duas (9,2%) a lesões inflamatórias, cinco (22,6%) a lesões papilíferas e uma (4,6%) a hiperplasia de células colunares. Foram encontrados 17 escores 2, quatro escores 3, um escor 4 e nenhum escor 1, com especificidade de 95%. CONCLUSÃO: As lesões císticas mamárias têm diferentes apresentações à elastografia, conforme o resultado histológico, sendo este um método útil para a sua diferenciação e de fácil aplicabilidade na clínica diária. Unitermos: Cisto mamário; Ultra-sonografia; Mama.


INTRODUCTION

The utilization of breast ultrasonography was disseminated in the eighties as an ancillary method in the differentiation between solid and cystic lesions of the breast, aiding in the diagnosis of nodules detected by mammography⁴.¹ Since the decade of 1990, with the introduction of higher frequency transducers, ultrasonography has allowed not only the differentiation between solid and cystic lesions, but also a clear-sighted analysis of the lesions, consolidating its role as an adjuvant diagnostic method up to nowadays when it is proposed by some authors as a method of screening for breast cancer in young women who have presented dense breasts at mammography (BI-RADS® categories 3 and 4)²⁻⁴.

One of the problems resulting from the widespread utilization of ultrasonography as a method for screening in these patients was the visualization of new alterations in the breast tissue generally not related to malignancy. Frequently, nodules usually associated with benignity which typically could not be visualized started being detected, with the presence of cysts with a thick content (complicated cysts). These cysts can hardly be differentiated from true nodules by the conventional method, and
generally are classified as indeterminate
nODULES, causing anxiety in the patients
who end up opting for diagnostic breast
biopsy.\(^{16,4}\)

One of the greatest challenges for ultra-
sonography is to allow the differen-
tiation between these two entities without in-
creasing costs or necessity of interventional pro-
cedures. Studies aiming at increasing the
ultrasonography accuracy have been de-
veloped about methods supplementary to ul-
trasonography to increase its accuracy, with
the development of Doppler fluxmetry,
ultrasound harmonic imaging, ultrasound
elastography and the streaming detection
technique in breast ultrasonography.\(^{7-10}\)

The present study approaches the fea-
tures of cystic breast lesions at ultrasound
elastography in correlation with a scoring
system developed by the authors, in pa-
tients referred to the Institution for diagno-
tic biopsy. Also, the clinical applicability of
the method is discussed.

**MATERIALS AND METHODS**

Retrospective study approved by the
Institutional Committee for Ethics in Re-
search, developed at the Unit of Imaging
Diagnosis of Santa Casa de Misericôrdia de
São Paulo, evaluating histological results
of 150 patients in the age range between 24
and 70 years (mean, 45 years) who pre-
sent 170 lesions at conventional ultra-
sonographic studies and were referred to
the Center of Computed Tomography for
percutaneous breast biopsy in the period
between May 1st and June 30, 2007. The
mean diameter of lesions was 1.4 cm (me-
dian, 1.2 cm; range, 0.5–3.2 cm). One hun-
dred and thirty patients with 148 exclu-
sively solid lesions at histology were ex-
cluded. The remaining 20 patients with 22
lesions histologically diagnosed as purely
cystic (complicated cysts), inflammatory
lesions and ductal ectasia, or cystic lesions
associated with solid components, such as
papillary lesions and typical columnar cell
hyperplasia, based on 17 (91.9%) fragment
biopsies and 5 (8.1%) preoperative needle
localization.

**Pathological diagnosis**

Specimens were sent for histological
study and were analyzed by a specialized
pathologist with 17-year experience in
breast lesions. The lesions were classified
into cysts, papillary lesions, inflammatory
lesions, typical columnar cells hyperplasia
and ductal ectasia.\(^{10,12}\)

**Equipment**

Both the conventional study and the
elastography were performed by a same
radiologist with six-year experience in breast
imaging, utilizing a Sonix SP (Ultrasound
Medical Corporation; Vancouver, Canada)
ultrasonography system with a 5–14 MHz
multifrequency linear transducer. A special
software specifically designed for Ultra-
sonix equipment (version 3.0.2 [Beta 1]),
whose license for experimental utilization
in research had been granted to the main
author, was utilized. No adverse reaction
was reported during the development of
the present study.

**Technique**

Firstly, a conventional imaging of the
breast was performed, with the patients
positioned in horizontal dorsal decubitus
with the hands under their heads. Mode B
and color Doppler images were obtained to
evaluate the nodules vascularization, ac-
cording to the BI-RADS\(^{\circledast}\) criteria. Mea-
surements were performed by B mode on
the longitudinal and antero-posterior axes,
the highest measurement being considered
for analysis. Subsequently, ultrasound
elastography was performed, also with
the patients positioned in horizontal dorsal
decubitus, and with the transducer perpen-
dicular to the chest wall. Previously to the
scan, compression was exerted on the le-
non to assure that it was not laterally dis-
placed. Once the elastography mode was
activated, serial compressions and decom-
pressions were performed on the area of
interest, with compressions not > 1% of the
total breast thickness, allowing the investi-
gator a real time monitoring of the behav-
or of the breast tissue under compression.
The area selected for investigation in-
cluded from the subcutaneous cellular tis-
sue to the pectoral musculature and tissues
adjacent to the nodule up to 0.5 cm. After
the images acquisition, a reevaluation was
undertaken by means of cinememory. The
examination time did not exceeded five
minutes.

**Ultrasonographic analysis**

The sonographic analysis followed the
BI-RADS\(^{\circledast}\) Atlas criteria, where anechoic,
circumscribed masses with imperceptible
walls, with acoustic shadowing are clas-
sified as simple cysts;\(^{13}\) complicated cysts,
lesions with a homogeneous internal con-
tent, slightly thickened walls, fine tissue
débris in suspension or intermingled fine
septa, and posterior acoustic shadowing;
indeterminate lesions, lesions with homo-
geneous content intermingled with fine
echoes, with no evident posterior acoustic
shadowing and imperceptible walls; com-
plex cystic lesions, with gross septa > 0.5
mm or with a mural nodule occupying less
than 50% of the cyst; nodules with a solid
component of more than 50% of the cyst.
No simple cyst was considered for the pur-
poses of the present study, because of the
BI-RADS\(^{\circledast}\) classification criteria including
it in category 2.\(^{14,15}\)

**Classification of elastography findings**

Elastography reflects a variation in a
color spectrum corresponding to the elas-
ticity of the different tissues present in a
sonographic sample, where red corre-
sponds to softest components like fat, yel-
low and green to intermediate components,
and blue to the hardest components like
hypercellular lesions or those with an in-
tense fibrosis (Figure 1).\(^{16}\)

The proposed elasticity classification
included four scores corresponding to the
colors variation during compression and
after decompression of the area of interest.
Score 1 was assigned to lesion presenting
the same color spectrum of the surround-
ing breast tissue. Score 2 was assigned to
lesions that after decompression presented
a color variation corresponding to softer
tissues involving more than 50% of the
nodule, i.e., after decompression, an area
 corresponding to more than half of the
nodule presented a color ranging in a scale
from green to red. Score 3 was assigned to
lesions that, after decompression, presented
a color variation in less than 50% of the
nodular area (between 10% and 50%), gen-
erally in the periphery, ranging in a scale
from yellow to green. Finally, score 4 cor-
responded to lesions with no significant
variation in color during compression and
after decompression, remaining as blue in
both images. Scores 1 and 2 corresponded to benign lesions; score 3, to low likelihood of malignancy; and score 4, to high likelihood of malignancy (Table 1).

RESULTS

Pathological diagnosis

Thirteen (59%) of the 22 lesions corresponded to apocrine cysts, one (4.6%) to ductal ectasia, two (9.2%) to inflammatory lesions, five (22.6%) to papillary lesions, one (4.6%) to columnar cell hyperplasia. 

Sonographic presentation

All the apocrine cysts presented like indeterminate nodules. Ductal ectasia and two inflammatory lesions presented like complicated cysts. Three (60%) of the five papillary lesions presented like indeterminate nodules, and two (40%) like complex cysts; and the columnar cell hyperplasia like complex cyst (Table 2).

Elasticity scoring

All of the 13 apocrine cysts were assigned score 2 (Figure 2). The ductal ectasia and inflammatory lesions were also assigned score 2. One of the five papillary lesions was assigned score 2 and the other four, score 3 (Figure 3). The columnar cell hyperplasia was assigned score 4 (Figure 4; Table 3).

DISCUSSION

In the last decade, ultrasound elastography has attracted a lot of attention to the assessment of soft tissues with the clinical prospect of allowing the early detection of lesions which determine pathological alterations, and providing appropriate management of these lesions with the consequent improvement in the prognosis for the patients. Information provided by this method are similar, but more sensitive and less subjective than to the ones obtained with manual palpation.

The pioneering study developed in 1991 by Ophir et al., proposed a classification according to the elasticity variation, based
Table 3  Cystic lesions presentation at elastography according to histological results.

<table>
<thead>
<tr>
<th>Histological results</th>
<th>Elastography scores</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Cysts</td>
<td>–</td>
<td>13</td>
</tr>
<tr>
<td>Ductal ectasia</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Papillary lesions</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>Columnar cell hyperplasia</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
| Total                    | –   | 17  | 4   | 1   | 22  

Figure 2. Example of score 2 elastogram. Indeterminate nodule at conventional mode (left image), utilizing compression (central image), and post-decompression elastography (right image). During compression, the greenish blue color in the center of the nodule is observed; after decompression, almost the whole nodule presents a greenish color.

Figure 3. Example of score 3 elastogram. A complex cyst at the conventional mode (left image) utilizing compression (central image), and post-decompression elastography (right image). During compression a greenish color is observed in the peripheral cystic area, and a bluish color is observed in the mural nodule; after decompression, the cystic area changes to red, while the mural nodule presents a change of about 10–50% to greenish blue.

Figure 4. Example of score 4 elastogram. A complex cyst at the conventional mode (left image) utilizing compression (central image), and post-decompression elastography (right image). During compression, a blackish-dark blue color is observed in the central portion of the cyst, and the mural solid portion does not present any significant alteration. Also, a change of the cystic component is observed in the lower border of the cyst with color variation during compression and after decompression.

on the principle that benign lesions were softer, whereas most of the malignant ones were harder. Elastographic images were obtained by means of comparison between pre- and post-breast tissue compression images. Since then, several studies have been published, although with no standardization of the technique or classification, most of them approaching only a comparison between pre- and post-compression images.
Features of cystic breast lesions at ultrasound elastography

No study describes the findings in cystic alterations of the breast that many times may generate anguish in women similar to the one caused by malignant nodules, although they generally are associated with benign lesions or lesion with low malignancy potential. Frequently, these lesions are interpreted as indeterminate nodules by the conventional approach, requiring an short-term follow-up and invariably leading to unnecessary diagnostic biopsies\textsuperscript{(19)}.

Simple cystic lesions present a typical aspect at US, as a circumscribed nodule with imperceptible walls, with an anechoic content and posterior acoustic shadowing, classified as BI-RADS\textsuperscript{®} 2, whereas solid lesions typically present like circumscribed, ovoid nodules parallel to the skin, classified as BI-RADS\textsuperscript{®} 3. However not all the cystic lesions present with the same features; some of them are hardly differentiated from solid nodules, particularly those with a thick fluid content, sometimes with fine debris in suspension, being classified as indeterminate nodules. Considering their low malignancy potential (about 2%), a short-term follow-up is recommended, despite the controversy and lack of a consensus about this matter. Most frequently, the short-term follow-up protocol adopted is a new study performed in a ten-month term, evaluating the area partially darkened at the mammogram and, in cases of lesions undetected by mammography, only ultrasonography was performed. The subsequent follow-up study is performed 12 months after the first one, but with bilateral mammography and ultrasonography, considering that one year is the term for breast cancer screening, followed by another study one year afterwards. Provided the lesion has remained stable for this two-year period, the final BI-RADS\textsuperscript{®} category is altered to 2. Cases where there is an alteration in the borders of the lesion or an approximate increase of 10% in its initial diameter, demand percutaneous biopsy\textsuperscript{(4,5)}.

On the other hand, a consensus has been achieved as regards the necessity of surgical excisional biopsy - the golden standard in cases of complex cysts. With the introduction of vacuum-assisted biopsy for breast lesions diagnosis, this method started being adopted because it can be easily performed on an outpatient basis and with low complication rates. In these cases, the B-mode ultrasonographic image is a determining factor in the approach to be adopted, as far as BI-RADS descriptive criteria are utilized. Little controversy remains about the approach to be adopted in these cases\textsuperscript{(5)}.

An attempt of a conventional approach with harmonic imaging and supplementary Doppler fluxmetry has been undertaken aiming at minimizing this limitation of ultrasonography; however, no significant increment was achieved in relation to the conventional method. In recent studies utilizing the so called “streaming detection” - where the response of the cystic internal content to the acoustic energy generated by the US transducer detected by Doppler is evaluated -, cystic lesions would have presented a response to Doppler, and the solid lesions would not. Experiments are still in development, with few studies published in the literature, but this method may be useful in the differentiation of indeterminate nodules\textsuperscript{(7)}.

Elastography, originally introduced to ultrasonography for differentiating benign from malignant breast lesions, can also be utilized for differentiating solid from cystic lesions, considering that the cyst elasticity is higher than the one of the adjacent parenchyma. Additionally, this method can be useful as an adjuvant in the evaluation of complex cysts, especially in the presence of mural nodules, whose hardness can be determined. In the present study, all of the cysts histologically diagnosed were sonographically characterized as indeterminate nodules, and assigned score 2, benign by elastography. Cysts with inflammatory content and ductal ectasia were sonographically characterized as complicated cysts, also with score 2 by elastography. These lesions presented a low malignancy potential and biopsies could be avoided if the features at ultrasound elastography had been taken into consideration.

Three (60%) of the papillary lesions presented as indeterminate nodules, and two (40%), as complex cysts at the conventional method; at elastography, one (20%) was assigned score 2, and the other four (80%), score 3. The score 2 lesion was sonographically classified as indeterminate nodule and measured 0.5 mm in its largest axis. This lesion would be considered as benign by elastography, and the patient would return for breast cancer screening in one year. However, this lesion was surgically excised and confirmed as benign. Two (50%) of the other four (80%) lesions with low suspicion for malignancy at elastography (score 3) were submitted to surgical excision and had their benignity confirmed; and for the other two lesions (50%) follow-up was recommended, considering their two-year stability.

On the other hand, the typical columnar cell hyperplasia was sonographically characterized as a complex cyst, with score 4 at elastography, indicating a malignancy potential. This lesion was also submitted to surgical excision, with histologically confirmed benignity; i.e., this was the false-positive result found in the present study.

One of the limitations for cystic lesions evaluation by elastography is the serial compressions intensity; The higher the intensity, the more the superficial tension of the internal fluid content is increased, determining the characterization as solid lesion according to the color spectrum (Figure 5). The advantage is that, as a real-time method, the investigator is allowed to measure the compression intensity during the examination according to the different types of breast and lesion to be evaluated. This increase in the superficial tension of the intracystic fluid also can be observed in secretory lesions, like in the case of the columnar cell hyperplasia and also in some inflammatory cysts.

Currently, the authors are developing studies based on their own criteria aiming at demonstrating the elastography sensitivity, specificity and diagnostic accuracy. Preliminary data of 170 nodules have demonstrated 80% positive predictive value, 97.5% specificity, and 97.7% diagnostic accuracy for the proposed classification.

The present study demonstrated that elastography can be useful in the diagno-
sis of cystic breast lesions, confirming their etiology, and that the introduction of this method in the clinical routine could reduce the number of unnecessary biopsies and conventional follow-up. This method could also be utilized as a supplementary study in cases of complex cysts for evaluating their internal content, but diagnostic biopsy should not be contra-indicated, considering the significance of B-mode findings.

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