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● *Original Contribution*

AUTOMATED BREAST VOLUME SCANNING: IDENTIFYING 3-D CORONAL PLANE IMAGING FEATURES MAY HELP CATEGORIZE COMPLEX CYSTS

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Abstract—The study described here sought to identify specific ultrasound (US) automated breast volume scanning (ABVS) features that distinguish benign from malignant lesions. Medical records of 750 patients with 792 breast lesions were retrospectively reviewed. Of the 750 patients, 101 with 122 cystic lesions were included in this study, and the results ABVS results were compared with biopsy pathology results. These lesions were classified into six categories based on ABVS sonographic features: type I = simple cyst; type II = clustered cyst; type III = cystic masses with thin septa; type IV = complex cyst; type V = predominantly cystic masses; and type VI = predominantly solid masses. Comparisons were conducted between the ABVS coronal plane features of the lesions and histopathology results, and the positive predictive value (PPV) was calculated for each feature. Of the 122 lesions, 90 (73.8%) were classified as benign, and 32 (26.2%) were classified as malignant. The sensitivity, specificity and accuracy associated with ABVS features for cystic lesions were 78.1%, 74.4% and 75.4%, respectively. The 11 cases (8.9%) of type I–IV cysts were all benign. Of the 22 (18.0%) type V cysts, 16 (13.1%) were benign and 6 (4.9%) were malignant. Of the 89 (72.9%) type VI cysts, 63 (51.7%) were benign and 26 (21.3%) were malignant. The typical symptoms of malignancy on ABVS include retraction (PPV = 100%, $p < 0.05$), hyper-echoic halos (PPV = 85.7%, $p < 0.05$), microcalcification (PPV = 66.7%, $p < 0.05$), thick walls or thick septa (PPV = 62.5%, $p < 0.05$), irregular shape (PPV: 51.2%, $p < 0.05$), indistinct margin (PPV: 48.6%, $p < 0.05$) and predominantly solid masses with eccentric cystic foci (PPV = 46.8%, $p < 0.05$). ABVS can reveal sonographic features of the lesions along the coronal plane, which may be of benefit in the detection of malignant, predominantly cystic masses and provide high clinical values. (E-mail: yuxinjiangxh@163.com) © **2016 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Sonography, Cystic breast lesion, Automated breast volume scan, Breast neoplasm, Benign or malignant, 3-D.**

INTRODUCTION

Cystic breast lesions are common, particularly among women aged 35–50 y, with an incidence of 3.9%–7.6% reported in the literature. In one study, 103 (3.9%) cystic lesions were found in 2646 women who underwent breast sonography in Thailand (Pongrattanaman and Prueksadee 2013). A large study in the United States reported 4562 breast sonograms interpreted by radiologists revealed 347 complex cysts (7.6%) in 285 women (Venta et al. 1999). Another report on a database of 2072 image-guided procedures performed at the University of Maryland Medical Center in the United States identified 150 cystic lesions, representing 7.2% of all lesions (Berg et al. 2003). Most cystic breast lesions are benign. The likelihood of malignancy is 0.3% for cystic breast lesions and 22% for all cystic lesions. Venta et al. (1999) reported only 1 of 308 (0.3%) complex cysts was cancerous. Berg et al. (2003) investigated 150 lesions, 18 (12%) of which proved to be malignant. A total of 99 breast cystic lesions in 83 women who underwent needle biopsy or surgical excision were studied at Shanghai Rui Jin Hospital in China. The total malignancy rate of these lesions was 14.1% (Chen et al. 2014). A total of 152 consecutive pathologically proven complex cystic lesions in the United

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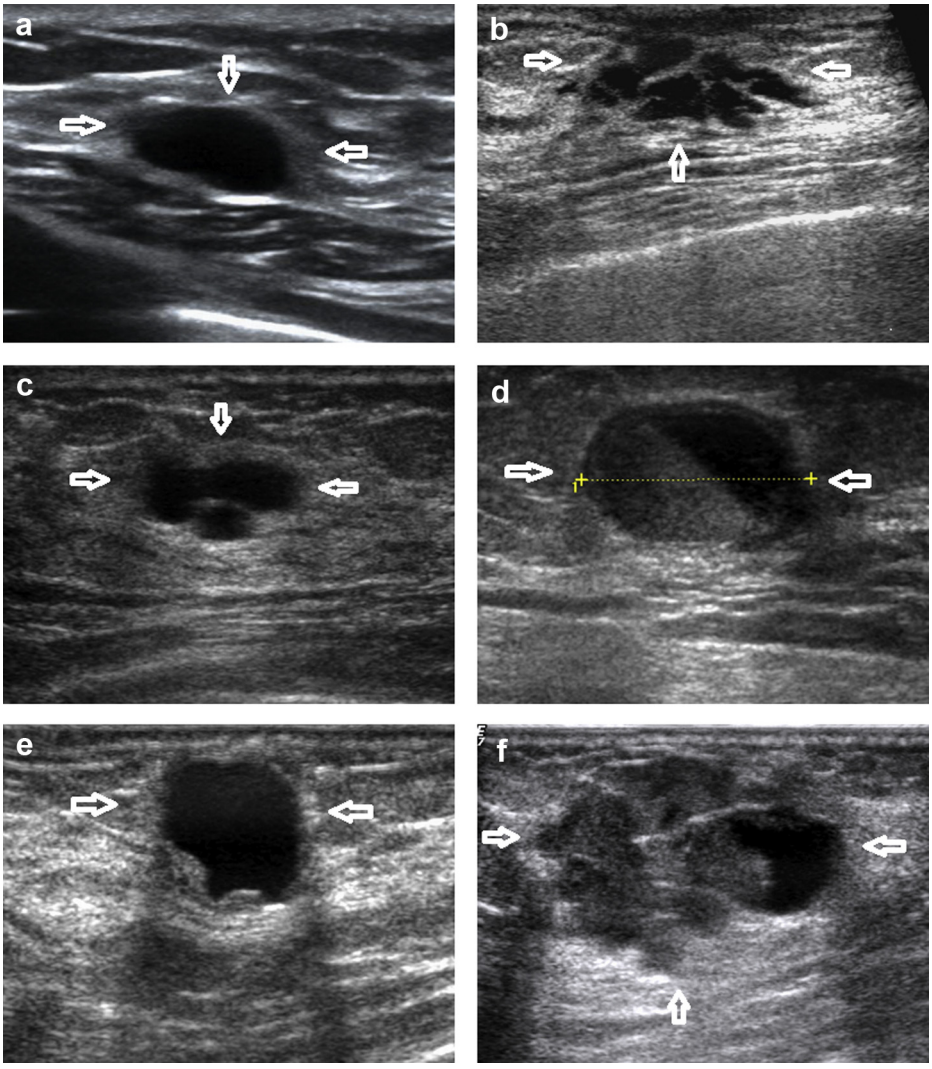

Fig. 1. Categories of cystic breast lesions (*arrows*) based on automated breast volume scanning sonographic imaging. (a) Type I simple cyst exhibiting an anechoic area associated with a thin wall, accompanied by posterior echo enhancement. (b) Type II clustered cysts revealing no echo or solid contents within. (c) Type III large cystic masses with perceptible small, thin septa. (d) Type IV complex cyst with heterogeneous, low-level echoes, fluid cell debris, and fluid–fluid interface formed by liquid and cell debris. (e) Type V predominantly cystic masses with >50% cystic contents and with characteristics of thick walls with or without septa (>0.5 mm) or solid lumps within the wall. (f) Type VI predominantly solid masses with <50% cystic contents, with predominantly solid contents accompanied by eccentric cystic foci.

States were retrospectively reviewed in Taiwan; the histologic analysis revealed malignancy in 33 (22%) (Hsu et al. 2011).

Breast sonography has an established role in the evaluation of breast abnormities and is useful for the early diagnosis of malignancy by accurate determination of cystic lesion features on sonographic images. Clinical sonographic images of cystic breast lesions are complicated and do not usually exhibit specific features, resulting in difficulty in the detection of malignant lesions (Athanasiou et al. 2014; Houssami et al. 2005; Hsu et al. 2011; Huff 2009; Omori et al. 1993; Rinaldi et al. 2010). Automated breast volume scanning (ABVS) can provide additional diagnostic information. The ABVS technique can be used to identify duct sections in breast papillary lesions by providing a coronal representation of the ductal system in the whole breast (Zhu et al. 2013). However, whether the coronal plane is better able to distinguish the symptoms of this type of lesion and thereby help in diagnosis remains to be determined. Therefore, this study sought to identify, using the coronal view, the specific US ABVS features that distinguish benign from malignant lesions by analyzing ABVS sonographic images for cystic breast lesions.