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● *Original Contribution*

VALUE OF THREE-DIMENSIONAL CONTRAST-ENHANCED ULTRASOUND IN THE DIAGNOSIS OF SMALL ADNEXAL MASSES

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Abstract—The main purpose of this study was to determine whether three-dimensional contrast-enhanced ultrasound (3D-CEUS) can provide useful information to distinguish malignant from benign adnexal masses (≤4 cm). Forty-seven patients with 51 adnexal masses were examined with 3D-CEUS. The sonographic features of masses were analyzed. All diagnoses were confirmed by surgical pathology and long-term follow-up results. The 51 masses included 43 benign and 8 malignant lesions. On 3D-CEUS images, benign lesions appeared as round structures formed by sparse and straight capillary vessels. Malignant lesions showed irregular stereo structures with dense and tortuous vascular distribution. A 3D-CEUS scoring system was established. There were no statistically significant differences in scores at each time point between the 20th and 70th seconds, and the area under the receiver operating characteristic curve for this time period was the largest (0.995). A cut-off score of 8 was established, with scores ≥8 being suggestive of malignancy. The 3D-CEUS scoring system had a high sensitivity (100%) and specificity (98%). 3D-CEUS is likely to be the new tool to distinguish malignant from benign small adnexal masses and diagnose early ovarian cancer. (E-mail: flower0118@163.com) © **2013 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Three-dimensional ultrasound, Contrast-enhanced ultrasound, Diagnosis, Adnexal mass.**

INTRODUCTION

Ovarian cancer is the leading cause of death in gynecological malignancy (Dev and Ivica 2005; Luo and Shi 2002). Early diagnosis and prompt treatment of ovarian cancer are essential to improve long-term survival.

Ultrasonography has become an important diagnostic tool for adnexal masses due to its many unique advantages such as non-radioactivity and flexibility in sectioning. The reported sensitivity and specificity of ultrasound in distinguishing benign and malignant adnexal masses are 93%–96.7% and 88%–98%, respectively (Cohen et al. 2001; Dai et al. 2008; Topuz et al. 2005). Although the use of ultrasound for the diagnosis of adnexal masses has been reported frequently, its efficacy for small lesions has rarely been studied. Currently, follow-up observations are recommended for adnexal masses <5 cm in diameter, whereas surgery is indicated for larger adnexal masses (Le and Xie 2006). However, many large malignant tumors, when discovered, are often at an advanced stage. Therefore, it is extremely important to distinguish early malignant tumors from benign ones when the lesions are still small.

Three-dimensional contrast-enhanced ultrasound (3D-CEUS) imaging, a new medical imaging technique that combines contrast-enhanced ultrasound (CEUS) and 3-D ultrasound (3D-US), will help ultrasonographers to develop a comprehensive visualization of the overall blood perfusions of the lesions and to overcome the shortcomings of incomplete scanning of 2-D ultrasound imaging. Although 3D-CEUS imaging has been used recently as a useful tool for clinical diagnosis, few studies have focused on its application to small adnexal lesions (Krenning et al. 2007; Leen et al. 2009; Yukisawa et al. 2007).

The main purpose of this study was to determine whether 3D-CEUS can provide useful information to distinguish malignant from benign adnexal lesions that

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Table 1. 3D-CEUS scoring system for small adnexal masses

Parameters	Criteria	Score
Surface	Regular	0
	Irregular	2
Wall thickness*	<3 mm	0
	≥3 mm	1
Inner wall structures	Smooth	0
	Rough	1
	Papillar <3 mm	1
	Papillar ≥3 mm	2
Septa	None	0
	Thin <3 mm	1
	Thick ≥3 mm	2
Contrast enhancement of the masses	None	0
	Mild	1
	Significant	2
Relationship with surrounding tissues	Normal	0
	Destroyed	1
Ascites	Absent	0
	Present	1

* When wall thickness and inner wall structure were indistinguishable, a maximum score was given.

are smaller than 4 cm preliminarily by observing the characteristics of these lesions and proposing a 3D-CEUS scoring system.

MATERIALS AND METHODS

Patients

Patients from the First Affiliated Hospital of Xinjiang Medical University with small adnexal masses (<4 cm) that were suspicious for malignancy were enrolled in this prospective study. Recruitment began in August 2009 (preliminary screening began in June 2009), and all patients completed testing by August 2011. Eligibility criteria were as follows: adnexal masses with a size equal to or less than 4 cm; transabdominal (TAS) or transvaginal ultrasound (TVS) examination demonstrating septa or papilla within the lesion; or part of the lesion or the entire lesion was low echo, medium echo or high echo. Exclusion criteria were as follows: allergic to SonoVue, refusal to sign informed consent forms, severe renal insufficiency, right-to-left shunt heart disease, pulmonary hypertension, adult acute respiratory distress syndrome, pregnancy or lactation, and age less than 18 years.

This study was reviewed and approved by the ethical committee of the First Affiliated Hospital of Xinjiang Medical University in March 2009 (protocol number 20090324) and met all criteria established by the Declaration of Helsinki. All patients provided written informed consent before their enrollment in the study.

Materials

The equipment used in the study was a contrast-enhanced MyLab90 ultrasound machine (Esaote, Genoa, Italy) with a transvaginal transducer (frequency range, 5–9 Hz). The 2-D and 3-D mechanical index was 0.08. The contrast agent used was SonoVue (Bracco, Milan, Italy). The contrast suspension was prepared by injecting 5 mL of water into the SonoVue vial and vigorously shaken for 5–10 s. A bolus of 2.4 mL of the contrast was administered via the antecubital vein followed by 5–10 mL of normal saline flush.

Procedures

Screening. Patients were screened by an ultrasonographer with TAS or TVS and only those who met the

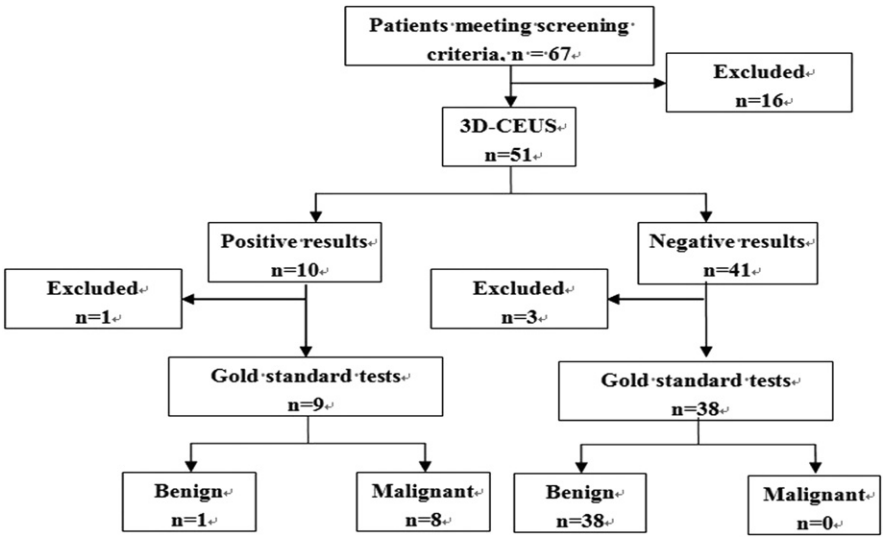

Fig. 1. Patient enrollment flow chart.