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● *Original Contribution*

PERITONEAL CARCINOMATOSIS IN PRIMARY OVARIAN CANCER: ULTRASOUND DETECTION AND COMPARISON WITH COMPUTED TOMOGRAPHY

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Abstract—We retrospectively compared detection rates and consistency for diagnosis of peritoneal carcinomatosis (PC) of primary ovarian cancer (OC) between ultrasound (US) and computed tomography (CT) scans in 41 patients whose PC of OC (stages IIC–IV) had been diagnosed by histopathology findings. Compared with CT detection rates, those for US were significantly higher for metastases to the pelvic area (92.3% vs. 43.6%, $p < 0.001$) and bowel surface (64.0% vs. 16.0%, $p = 0.002$); however, they did not significantly differ for other sites: omentum, diaphragm, lateral peritoneum, mesenteric, hepatic and splenic surfaces. Diagnostic consistency between US and CT scans were fair to moderate for splenic ($\kappa = 0.806$), hepatic ($\kappa = 0.485$), lateral peritoneum ($\kappa = 0.450$) and diaphragm ($\kappa = 0.338$) surfaces, but poorly consistent for other parts ($\kappa = 0.144$–0.229). In summary, US can complement CT scans, especially for detecting PC of primary OC metastases in pelvic and bowel surfaces.
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Key Words: **Ovarian cancer, Peritoneum, Peritoneal carcinomatosis, Ultrasound, Computed tomography.**

INTRODUCTION

Ovarian cancer (OC) is the sixth most commonly diagnosed cancer among women worldwide and causes more deaths per year than any other cancer of the female reproductive system (Permuth-Wey and Sellers 2009). It is one of the most occult cancers, as 70% of tumors are diagnosed in the late stages of disease (FIGO III and IV). In addition, 70% of OC patients present with involvement of the peritoneum (Nougaret et al. 2012; Sehouli et al. 2009; Woodward et al. 2004).

Aggressive surgery and chemotherapy are often combined to extend the survival of patients with OC; however, prognosis is still poor because of late-stage disease at diagnosis. The presence of a residual lesion after initial surgery is an important prognostic factor in patients with advanced OC. Therefore, detecting and detailing involvement of peritoneal carcinomatosis (PC) in patients suspected of having primary OC is critical. Ultrasound (US) is the least expensive technique; it is quick and simple to perform, even at the bedside, and is reportedly >90% accurate in detecting benign and malignant intra-abdominal ovarian masses (Valentin 1999). However, very few data are available in existing literature regarding the involvement of PC in primary OC. This study compared detection rates by US and computed tomography (CT) scans for PC and evaluated their diagnostic consistency.

METHODS

Study population

We retrospectively enrolled into this study 41 women who had been diagnosed with primary OC with PC by histopathology findings from January 2008 to December 2015. All 41 women had been hospitalized in the Department of Obstetrics and Gynecology in Peking Union Medical College Hospital. They were evaluated with US examinations and CT scans independently, and then underwent optimal or suboptimal primary debulking surgery within 10 d. All ultrasound examinations were performed and evaluated by the same senior ultrasound physician; CT scan results were reported by seven radiologists. Surgical findings and pathologic diagnoses were regarded as gold standards for evaluating US and CT scan results. Of the 41 patients, 14 were pre-menopausal and 27 were

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post-menopausal. None of them had taken estrogen during their lifetime. Only two patients had reported family histories of OC. This retrospective study was approved by the ethics committee of Peking Union Medical Hospital, which waived the need for written informed consent from the patients. All records data were de-identified and analyzed anonymously.

US examination

The US examinations were performed using a LOGIQ 9 (GE Healthcare, Milwaukee, WI, USA) or an IU22 or HD11 (Philips, Eindhoven, Netherlands) with 9- to 3- or 8- to 4-MHz vaginal probes for transvaginal ultrasound imaging and 5- to 2-MHz probes for trans-abdominal ultrasound imaging. Transvaginal scans of the pelvic peritoneum in longitudinal and transverse views were performed first, followed by trans-abdominal scans. Scans focused on omentum, hepatic and splenic surfaces, diaphragm, lateral peritoneum and bowel surface. When ascites was observed, mesenteric and intestinal surfaces were carefully examined. Size, echo and color Doppler flow imaging (CDFI) of pelvic and abdominal peritoneal implants were recorded, along with the boundaries and relationships with lesions in surrounding tissues. Imaging was saved simultaneously. Detected PC in the abdominal cavity was carefully recorded with respect to the area involved, which included bowel surface, hepatic and splenic surfaces, diaphragm, lateral peritoneum, omentum, mesenteric surface and pelvis.

Our method of examining patients for PC using ultrasound was as follows:

1. Pelvic implants: Transvaginal US was used to examine the pouch of Douglas, pelvic parietal peritoneum and surfaces of visceral peritoneum; lesions could be detected on of bowel, bladder, uterine and pelvic parietal peritoneum surfaces.
2. Omentum: Abdominal US of the upper and lower abdomen in the longitudinal or transverse direction was used. Lesions were usually located between the front abdominal wall and the bowel.
3. Hepatic surface: The patient was placed in the supine position. First, a transverse scan of the left liver at the level of the subxiphoid was performed. Then, an oblique scan was performed along the right costal margin of the liver, from left to right, followed by an intercostal oblique and coronal scan of the liver surface in the left lateral position.
4. Diaphragm surface: The right costal margin was scanned at an oblique angle, as was an intercostal oblique and coronal section in the left lateral position.
5. Splenic surface: Patient was moved to the right lateral position. The spleen can be examined *via* intercostal or left coronal scanning, moving the probe backward and forward.
6. Mesenteric and bowel surfaces: Patient was placed in the supine position. Hyper-echoic bowel could be observed in all four quadrants. Operator looked for implants on mesenteric and bowel surfaces while scanning.
7. Lateral peritoneum: Patient was placed in the right or left lateral position. The left or right lateral abdomen, adjacent to the side of the abdominal wall, was scanned from top to bottom.

Table 1. CA-125 levels and ascites volumes

CA-125 level (IU/mL)	n	Ascites volume (mL)	n
<100	2		
100–200	4	Non-ascites	4
201–500	10	≤500	12
501–1000	7	>500, ≤1000	8
1001–2000	6	>1000, ≤1500	9
2001–5000	7	>1500, ≤2000	5
>5000	5	>2000	3
Total	41		41

CT examination

Computed tomography scans were performed using GE 64-slice helical scanners (GE Medical Systems, Milwaukee, WI, USA). Images were reconstructed at 7-mm intervals. All patients received the intravenous contrast medium Ultravist (Bayer, Berlin, Germany) through a bolus injection with a high-pressure syringe through the forearm vessel at 3 mL/s. After injection of the contrast agent, arterial-phase, portal-phase and delayed-phase images were obtained after 30, 60, and 200 s, respectively. The scan range was from the top of the diaphragm to the pubic symphysis. Each physician recorded a diagnosis based on each CT scan.

Pre-operative descriptions of OC by abdominal pelvic CT included size, morphology and unilateral or bilateral character of ovarian masses; any features of malignancy; uterus, bladder, bowel, pelvic side-wall invasions or implants; ascites in the pelvis or upper abdomen and its

Table 2. Histologic findings in patients with persistently abnormal screens (n = 41)

Final pathologic type	N
Borderline serous papillary adenofibroma	1
Endometrioid carcinoma	3
Clear cell carcinoma	2
Sarcoma cancer (malignant mixed tumor müllerian)	2
Poorly differentiated neuroendocrine carcinoma	1
Serous papillary adenocarcinoma + endometrial carcinoma	2
Mucinous carcinoma	3
Serous papillary adenocarcinoma or cystadenocarcinoma	27
Total	41