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Original Research

Protocol of a Multi-Center Initiative to Create a Standardized Ovarian Ultrasound Image Database in China

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Abstract

Background: At present there is no large, multi-center and standardized database of ovarian ultrasound images for teaching and research in China. **Methods**: A standardized ovarian ultrasound image database is being created in a collaborative initiative of about 20 centers proficient in gynecological ultrasound imaging. The database will include both adults and children in China. **Results**: Each center will provide cases that meet the submission requirements, including standard normal cases (SNC), standard abnormal cases (SAC) and historical classic cases (HCC). This database will cover the majority of the spectrum of ovarian lesions in China. **Conclusions**: This comprehensive database of ovarian lesions will be a valuable resource for diagnosis and education.

Keywords: study protocol; database; ovarian lesions; ultrasound; education

1. Introduction

Ovarian cancer is the leading cause of gynecological cancer-related mortality globally [1,2] and ultrasound imaging is one of the main tools used in preoperative diagnosis [3]. The advantages of ultrasound imaging include the absence of ionizing radiation, its widespread availability and portability, its low cost and its ability to provide instantaneous results the operator. Ultrasound imaging continues to be a valuable diagnostic tool in many applications such as Point-of-Care Ultrasound (POCUS), extended Focused Assessment with Sonography for Trauma (eFAST) and others [4–6]. Accurate characterization of ovarian lesions as benign or malignant is of high clinical relevance [7]. Ultrasound plays a vital role in the diagnosis of ovarian masses and Moro *et al.* [8] described the clinical and ultrasound features of different subclasses of malignant serous ovarian tumors. Moreover, it can distinguish tubal cancer from ovarian cancer even though the prognosis and treatment are similar for these two cancers [9,10]. At ultrasound examination, lesion size and morphology are the key sonographic features used to triage women with adnexal masses for expectant or interventional management [11]. In surgically removed adnexal masses with a largest diameter of $\leq$2.5 cm, Di Legge A *et al.* [12] found that small unilocular cysts are usually benign, while small non-unilocular masses, particularly ones with solid components, incur a risk of malignancy and pose a clinical dilemma.

There are two major groups, the International Ovarian Tumor Analysis (IOTA) group and the Society of Radiologists in Ultrasound (SRU), that have published imaging criteria for characterization of adnexal lesions [13]. The IOTA group has developed a number of diagnostic strategies, such as Easy Descriptors, Logistic Regression Models 1 and 2 (LR1 and LR2) [14], Simple Rules [15,16], Simple Rules risk assessment [17], and Assessment of Different Neoplasias in the adneXa (ADNEX) model [18]. The ADNEX model includes clinical and ultrasound information to calculate the likelihood of malignancy and the likelihood of 4 subclasses of malignant tumors, which is clinically very relevant for guiding patient management [19]. The SRU has published expert evidence-based consensus guidelines with criteria for characterization and management of asymptomatic ovarian and other adnexal cysts [20]. Patel-Lippmann *et al.* [13] found both methods were sensitive for identifying ovarian malignancies and the IOTA simple rules were slightly more accurate than the SRU guidelines in receiver operating characteristic (ROC) analysis.

At present there is no large, multi-center and standardized database of ovarian ultrasound images for teaching and research in China. Yang *et al.* [21] created a database on focal liver lesions which ensured the quality of ultrasound images, reduced the difference between radiologists' diagnoses and provided a large-scale data basis for deep learning analysis. Chen *et al.* [3] examined 278 patients with at least one adnexal (ovarian, paraovarian or tubal) mass to evaluate the diagnostic accuracy of the ADNEX model, using data from a gynecological oncology center in China. Our precious study examined 620 patients from a single oncology center to validate the diagnostic accuracy of the ADNEX model in the hands of nonexpert ultrasonographers

[22]. To our knowledge, the database we propose in this study will be the largest, multicentric, and standardized ultrasound ovarian image data resource in China. The size and variety of the database will make it a valuable source for diagnosis as well as education on ovarian lesions.

2. Methods

2.1 Design and Data Collection

The database will be created within the data collection platform (DCP) of a medical image database. We aim to create an ovarian database of 10,000 cases, which will be provided by about 20 centers. Each center has undergone a standardized training and is expected to provide 501 cases. The years of experience in gynecological ultrasound were not a factor in inclusion. To ensure the quality of cases, the number of cases collected from each hospital can be revised after consultation. All the cases will meet the case submission requirements and can be selected at any patient age. The data will include standard normal cases (SNC), standard abnormal cases (SAC) and historical classic cases (HCC). The category of SAC will include: ovarian non-neoplastic cyst, benign ovarian tumor and ovarian malignant tumor. The case information will be uploaded electronically and saved on the platform.

2.2 Study Procedure

Only persons officially registered as study investigators can log into the DCP and submit data. Each center will submit case information through the network platform using a unique username and password. Each case submitted is required to meet the ultrasound measuring standard and case submission requirements. A group of specialists, who have undergone project training and have experience in ultrasonic diagnosis of ovarian tumors, will check the uploaded information to decide whether the case qualifies to enter the database. If a submitted case does not meet the ultrasound measuring or case submission requirements, it will be returned with a request for modification if possible. Only those cases that have been certified by an expert will be stored in the database. The submission and approval process are shown in Fig. 1.

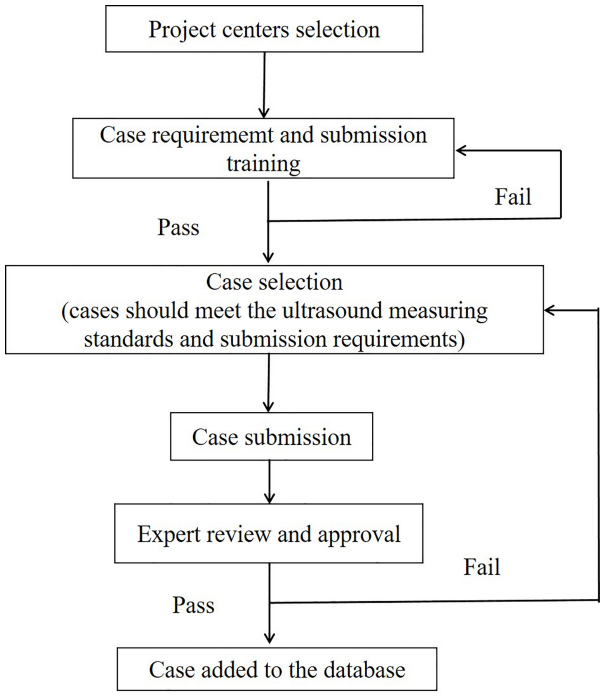

Fig. 1. Flow chart to create a standardized ovarian ultrasound image database. After successfully completing project training each site selects and submits cases that meet the requirements. Cases are reviewed by a specialist and either added to the database or returned for revision.

2.3 Ultrasound Measuring Standard

A standardized ultrasound examination following the IOTA protocol is carried out and evaluated as follows [23]. (a) All lesions will be classified into one of five types according to their ultrasonographic features. That is: unilocular, unilocular cyst with solid component, multilocular, multilocular with solid component and solid [23]. (b) Solid papillary projections are defined as a solid component which protrudes from the capsule wall more than 3 mm and is described as being 'smooth' or 'irregular' (e.g., cauliflower-like). (c) If the pelvic effusion exceeds the uterine floor, the ascites is positive. The thickness and diameter of the liquid dark area behind the uterus, bilateral iliac fossa, hepatorenal space and splenorenal space need to be measured. (d) The blood flow signals in the tumor septum, cyst wall or solid components are subjectively evaluated by sonographers as: no blood flow signal, a small blood flow, medium flow or rich flow. The color/power Doppler settings should be such as to allow detection of low blood flow velocities (usually a pulse repetition frequency of 0.3 to 0.6 kHz is appropriate). (e) The volume of the ovary is calculated from three diameters in two perpendicular planes. Additionally, the largest follicular length is measured. The method of measuring the volume of a lesion or tumor is the same as that of the ovary. (f) Dynamic images should be continuous sequential cross-sectional scans of about 2 to 5 seconds. The scans would move across the ovary or tumor while starting and ending outside the ovary or tumor field. All images will be derived from the ultrasonic machines.

2.4 Case Submission Requirements

Each of the trained participants from the approved sites will log into the system using the unique account number and password provided. Once logged in they would choose the "ovarian" mode and input the patient information. Required information in this step includes case category, sex, age, province, hospital name, sonographers, audit doctors, cause of visit, clinical diagnosis, examination time, ultrasound manufacturer, machine type, and others. The international classification of diseases is optional. Af-

Table 1. Medical history content required for submission for various case categories.

Medical history	Case category		
	SNC	SAC	HCC
Complaint	*	*	/
Height	*	*	/
Weight	*	*	/
Current medical history	*	*	/
Menstrual and reproductive history	*	*	*
Personal history of ovarian cancer and breast cancer	/	*	*
Surgery or not	/	*	*

*Required content. /Optional content.

SNC, standard normal cases; SAC, standard abnormal cases; HCC, historical classic cases.

Table 2. Ultrasonic images required for submission in standard normal cases.

Object	Required content*	Numbers of images
Left ovary	Volume calculated from three diameters in two perpendicular planes	2
	Two perpendicular planes without measurement	2
	The maximum diameter of the largest follicle	1
	The largest follicle section without measurement	1
	The section with the greatest number of follicles	1
Right ovary	Volume calculated from three diameters in two perpendicular planes	2
	Two perpendicular planes without measurement	2
	The maximum diameter of the largest follicle	1
	The largest follicle section without measurement	1
	The section with the greatest number of follicles	1
Left ovary	Dynamic image for 2 to 5 seconds	1
Right ovary	Dynamic image for 2 to 5 seconds	1
Uterus	Endometrial thickness in sagittal section	1
	Endometrial thickness in transverse section	1

*All the images acquired as gray-scale ultrasound.

ter this data input, a unique number will be automatically generated for each submitted case. The next step is to upload the full patient information, including medical history (Table 1), ultrasonic information (Tables 2,3,4), laboratory test report, pathological report, and any additional imaging performed (computed tomography (CT) scan/magnetic resonance imaging (MRI) scan) according to the choice of case category. The ultrasonic information will include original ultrasonic images and ultrasound reports and all the ultrasonic findings were obtained by the ultrasonographers who have successfully completed the standardized training. The required for ultrasonic information differs depending on the clinical diagnosis as shown in Tables 3,4. Additional requested information, including laboratory test reports, pathological reports and other examination reports, can be left unfilled, but benign and malignant cases must be confirmed by pathological results as well as the level of serum cancer antigen 125 (CA125) [24].

3. Discussion

Here, we describe the aims and methods of our project, to create a large-scale database on ovarian ultrasound images in China, containing standard normal cases, standard abnormal cases and historical classic cases. The number of patients and multi-center design will make the database a valuable resource for a broad range of studies on ovarian diagnostics. With the database as a platform, the next step will be to implement a prospective and ongoing database for future educations and studies.

The duration of the study is expected to be one and a half years, but it can be extended if delays are encountered. When choosing centers, priority will be given to gynecology and obstetrics hospitals, oncology hospitals or tertiary hospitals, so as to ensure timely case collection. At present there are 23 hospitals from 14 provinces that have started or are preparing to collect cases. The manufacturers and types of ultrasound machines vary in hospitals so the instrument

Table 3. Ultrasonic images required for submission in cases with clinical diagnosis of a non-neoplastic cyst*.

Object	Content	SAC	HCC
Diseased ovary[#]	Volume calculated from three diameters in two perpendicular planes	2	2
	Two perpendicular planes without measurement	2	/
	Plane with the largest number of cysts	/	/
Lesion[#]	Volume calculated from three diameters in two perpendicular planes	2	2
	Two perpendicular planes without measurement	2	/
Diseased ovary[#]	Dynamic image for 2 to 5 seconds	1	/
Uterus[#]	Endometrial thickness in sagittal section	1	1
	Endometrial thickness in transverse section	1	1
Lesion	Longitudinal section and transverse section (color doppler)	2	2
	Values in longitudinal or transverse section (spectral doppler)	1	/

*Including follicular cyst, ovarian corpus luteum cyst, theca luteinized cyst, parovarion cyst, polycystic ovary syndrome, and others. [#]Gray scale ultrasound. /Optional content.
SAC, standard abnormal cases; HCC, historical classic cases.

Table 4. Ultrasonic images required for submission in cases with clinical diagnosis of benign or malignant ovarian tumors.

Object	Content	SAC	HCC
Lesion[#]	Volume calculated from three diameters in two perpendicular planes	2	2
	Two perpendicular planes without measurement	2	/
	Plane with the largest number of cysts	/	/
Solid component[#]	Volume calculated from three diameters in two perpendicular planes	/	/
	Two perpendicular planes without measurement	/	/
Others[#]	All nipples, ascites, sound and shadow	/	/
Lesion[#]	Dynamic image for 2 to 5 seconds	1	
Uterus[#]	Endometrial thickness in sagittal section	1	1
	Endometrial thickness in transverse section	1	1
Blood flow	Section with the most abundant blood flow (color doppler)	1 to 3	1 to 3
	The most abundant blood flow section with measurements (spectral doppler)	1 to 2	/
	Section with the most abundant blood flow (3D color doppler)	1	/
Others*	Lesion site, solid part, nipples	1	/

[#]Gray scale ultrasound. *Three-dimensional ultrasound. /Optional content.
SAC, standard abnormal cases; HCC, historical classic cases.

specifications will be provided when uploading images to assist in data analysis. Due to different properties of different ultrasonic machines, each center will determine the optimal parameters to set for each specific machine.

In order to ensure the diversity of the database, each center is required to provide cases including SNC, SAC and HCC. Ovarian lesions can be classified as neoplastic or non-neoplastic while ovarian cysts are the most common non-neoplastic lesions [25]. Non-neoplastic cystic lesions of the ovary can be further divided into functional and non-functional cysts and can be diagnosed by pathological or a combination of clinical and imaging features in clinical practice. So only benign or malignant cases must be confirmed by pathological results as well as the level of serum cancer antigen CA125. Besides, our precious study [22] found that when including CA125 in ADNEX model, the performance in discriminating between stage II-IV ovarian cancer (OC) and stage I OC and between stage II-IV OC ovarian metastasis was improved. According to a tertiary center experience [26], ovarian lesions are not commonly seen in pediatric patients, but there are a few reported cases among different pediatric age groups. To ensure the diversity of cases, we have no age limit, but we estimate that there will be fewer pediatric cases.

When the database is completed, we will calculate the ovarian disease component, analyze the ultrasonic characteristics, set up an ovarian ultrasound image library for study and education, validate existing models, and analyze the images by pattern recognition and other advanced techniques.

4. Conclusions

In conclusion, we are creating a large-scale database of ovarian ultrasound images and accompanying patient medical history and diagnosis obtained from multiple centers in China. The data will be useful for a broad spectrum of studies, ranging from diagnostic analyses to medical education.

Author Contributions

JW and PH contributed to study design, data acquisition, writing and revising the manuscript. LG and YT contributed to data collection and database establishment. QW provided clinical expertise for the study design, arranged the data collection, writing and revising the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

This study was performed with ethics approval (Ethics Committee of Beijing Obstetrics and Gynecology Hospital, Capital Medical University. File no. 2019-KY-042-01). Informed consent was obtained from all individual participants included in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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