Introduction

Ovarian teratomas are the most common germ cell neoplasm and include mature cystic, immature, and monodermal teratomas. The former is the most common [1]. In a 10-year retrospective review of 861 women with a postoperative diagnosis of an ovarian
neoplasm, Koonings et al. found that 44% of all ovarian neoplasms were cystic teratomas [2].

As it often presents with characteristics US findings, the preoperative diagnosis of mature cystic teratoma is usually straightforward in most instances. The following US features have been reported to be characteristic of mature cystic teratomas: presence of posterior sonic shadowing, diffuse or focal hyperechogenicity, hyperechoic lines and dots, and fat-fluid levels [3-16]. Although many studies have been published on the preoperative US diagnosis of ovarian teratomas, only a few have tried to classify the morphological US features of ovarian teratoma [10-12].

In this study, the author aimed to establish the morphologic US classification and document reliable sonographic features in the diagnosis of mature cystic teratoma of the ovary.

Materials and Methods

The records of ovarian lesions coded as teratoma over a 4-year period were retrieved from the database archived by the department of pathology at our institution. The group comprised 112 mature cystic teratomas.

Fig. 1. Diagrams and corresponding US images of mature cystic teratoma of the ovary classified into 6 groups based on the morphologic US features.

I. Unilocular anechoic cyst
II. Unilocular cyst with low-level internal echoes
III. Hyperechoic lines and dots in a cyst
IV. Hyperechoic areas within a cyst
V. Solid and cystic mass
VI. Diffusely hyperechoic mass
in 103 patients who had undergone tumor resection or unilateral or bilateral salpingo-oophorectomy within 4 months following pelvic US. The patient age ranged from 10 to 62 years (mean 33 years).

US was performed using an ATL-HDI 3000 or ATL-5000 (Advanced Technology Laboratories, Bothell, WA, U.S.A.). The pelvic US was performed via the transabdominal approach alone using a 3.5-5.0 MHz convex transducer in 38 patients, the transvaginal approach alone using a 7-10 MHz endovaginal transducer in 14 patients, and both transabdominal and transvaginal approaches in 51 patients. Color Doppler US (CDU) was performed in all patients.

One radiologist retrospectively analyzed the US findings. According to the morphologic US features, the tumors were classified into 6 groups: unilocular anechoic cyst (type I), unilocular cyst with low-level internal echoes (type II), hyperechoic lines and dots in the cyst (type III), hyperechoic areas within the cyst (type IV), solid and cystic mass (type V), and diffusely hyperechoic mass (type VI) (Fig. 1). We defined type IV as mainly a cystic mass with protruding hyperechoic areas from the cystic wall, and type V as tumors that intermingle with the solid and cystic areas. Therefore, types I-IV were cystic tumors, type V mixed, and VI solid tumor. For each tumor, the additional US findings of posterior sonic shadowing and fat-fluid level, and tumor vascularity on CDU were also evaluated. The author investigated the difference in US appearance between transabdominal and transvaginal approaches.

**Results**

The common US patterns were hyperechoic area within a cyst (type IV; 36 tumors, 32.1%), solid and cystic mass (type V; 32 tumors, 28.5%), and a diffusely hyperechoic mass (type VI; 25 tumors, 22.3%), followed by hyperechoic lines and dots in the cyst (type III; 8 tumors, 7.2%), a unilocular cyst with low-level internal echoes (type II; 6 tumors, 5.4%), and a unilocular anechoic cyst (type I; 5 tumors, 4.5%). All solid and cystic masses (type V) had hyperechogenicity in at least one solid portion with the results that hyperechogenicity within a mass was seen in 93 of the 112 tumors (83.0%).

Of the 112 tumors, 68 (67.1%) showed posterior sonic shadowing which was demonstrated only in the hyperechoic area of types IV-VI. Six tumors (5.3%) showed fat-fluid level. Of 55 cystic masses (types I-IV), 46 (83.8%) showed a smooth and thin (<3 mm) cystic wall and nine (16.2%) showed an irregular and thick wall. On Doppler study, 14 tumors showed tumor vascularity in the outer wall (n = 8), septum (n = 3), and center of mass (n = 3), whereas the rest of the tumors were avascular. The resistive indices ranged from 0.37 to 0.79.

**Fig. 2.** US images in a 31-year-old woman who underwent both transabdominal and transvaginal approaches. Transabdominal US (A) demonstrates a cystic mass containing hyperechoic area. The hyperechoic area within the cyst was better seen on transvaginal US (B).
In 51 patients who underwent both transabdominal and transvaginal US, the US appearances of the tumor were not sufficiently different to change the differential diagnoses. The hyperechoic area within the tumor was better seen on transvaginal US in four patients (Fig. 2).

**Discussion**

Owing to heterogeneous histological components, ovarian cystic teratomas demonstrate variable US appearances. Laing et al. [10] classified these ovarian teratomas into three groups of complex cystic mass containing hyperechoic foci, solid mass and simple cyst. Caspi et al. [11] proposed a classification of the pathognomonic echo patterns of ovarian cystic teratomas based on three basic types of echo pattern: echogenic mass, echogenic particles in a hypoechoic medium within the tumor, and a cyst with fat-fluid level. Their classifications included only partial US patterns of ovarian teratomas. Sandler et al. [12] divided the US patterns of ovarian teratoma into 8 categories based on their consistency and internal echo pattern, but this classification system was limited due to the small study population and failure to include hyperechogenicity, which is characteristic of ovarian teratoma. In the present study, the common US patterns were hyperechoic area within a cyst (type IV), solid and cystic mass (type V), and a diffusely hyperechoic mass (type VI). This result corresponds with that of the study of Laing et al [10]. Our study was significant in that the cystic tumors were subdivided according to the echo pattern of cystic fluid and the presence of mural nodule. In addition, the inclusive classification of mature cystic teratoma, including uncommon as well as common US findings, was proposed with a relatively large study group of 112 pathologically-proven cases.

The gross pathologic appearance of mature cystic teratomas is characteristic. The tumors are mostly unilocular and are filled with sebaceous materials, which are liquid at body temperature and semisolid at room temperature [17]. Squamous epithelium lines the wall of the cyst, and compressed, often hyalinized, ovarian stroma covers the external surface [18,19]. Hair follicles, skin glands, muscle, and other tissues lie within the wall. There is usually a raised protuberance (Rokitansky nodule) projecting into the cyst cavity. Most of the hair typically arises from the protuberance. In this study, 61 of the 112 tumors (54.5%) showed focal or diffuse hyperechogenicity on US. These focal and diffuse hyperechogenicities are caused by Rokitansky nodule and hair mixed with the cyst fluid, respectively [1].

Acute hemorrhage into an ovarian cyst or an endometrioma can be echogenic and may mimic ovarian teratoma. However, the presence of posterior sonic enhancement in hemorrhagic cyst can be helpful in the differentiation from teratoma, which tends to attenuate the sound [12]. Posterior sonic shadowing, a characteristic finding of ovarian teratoma, was seen in 67.1% of the cases. A diffusely or partially echogenic mass usually demonstrates posterior sonic shadowing owing to sebaceous material and hair within the cyst cavity [16,20]. In addition, bones or teeth located within the Rokitansky nodule bring out posterior sonic shadowing. The epidermoid plug produced by aggregation of hair usually demonstrates posterior sonic shadowing that is gradually attenuating in intensity, whereas teeth and bones show discrete posterior sonic shadowing [10, 14].

Fat-fluid level is an uncommon US finding but is considered a pathognomonic sign of benign ovarian teratoma [2]. This result from the echogenic sebum and the hypoechoic serous fluid produced by the sebaceous and sweat glands, respectively. Sandler et al. [12] observed this pattern in one of 40 patients with mature cystic teratoma. In this study, only 6 of 112 tumors demonstrated fat-fluid level. Ower at al. [3] suggested that this low incidence is because mature cystic teratomas seldom simultaneously contain the elements producing sebum and those producing serous fluid.

Zalel et al. [21] reported that blood flow was detected from the cyst capsule in 24% of mature cystic teratomas. They proposed that blood flow in the central solid portion of the sonographically suspected, mature cystic teratoma is highly suggestive of struma ovarii. In this study, blood flow was detected in 15 tumors (cyst capsule, 9; central solid portion, 3; septum, 3). However, no tumor was surgically proved to be struma ovarii.

This study had several limitations. As a retrospective study, only those who had surgery were included. Although the author tried to establish an inclusive morphological classification, which included all possible US patterns of ovarian teratoma, it may have been arbitrary and may not have included some usual US patterns.
In conclusion, this study has suggested a new inclusive classification of mature cystic teratoma of the ovary. The common US patterns are hyperechoic area within a cyst, solid and cystic mass, and a diffusely hyperechoic mass. Mature cystic teratomas often contain a shadowing hyperechogenicity. Therefore, any adnexal masses representing a hyperechoic area within a cyst, solid and cystic tumors containing hyperechogenicity or diffusely hyperechoic mass, especially when accompanied by posterior sonic shadowing, should be suspected as indicative of mature cystic teratoma.

References

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**제목:**

112

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**대상:**

112

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**결과:**

- 103
- 112

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**방법:**

6

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**결과 해석:**

6

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**고찰:**

- 103
- 112

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**증후군 분석:**

- 36 (32.1%)
- 32 (28.5%)
- 25 (22.3%)

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**결과 해석 2:**

- 19 (17.1%)
- 68 (67.1%)

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**고찰 2:**

- 103
- 112

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**결과 해석 3:**

- 4
- 5
- 6

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**고찰 3:**

- 103
- 112