Imaging diagnosis of pregnancy-associated ovarian tumors

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Objective: To investigate the possibility of prediction of the histological type of ovarian tumors by preoperative imaging in patients had undergone surgery for pregnancy-associated ovarian tumors.

Methods: Maternal ovarian tumor was detected by ultrasonography (USG) examination and magnetic resonance image (MRI) and operation was performed in 18 pregnant women.

In 18 cases, collected medical records, USG/MRI and pathologic findings were analyzed retrospectively.

Results: Histopathological diagnoses were parovarian cyst, simple cyst, mucinous cystadenoma, a combination of mucinous cystadenoma and mature cystic teratoma, mature cystic teratoma, hemorrhagic lutein cyst, immature teratoma (Grade1), a combination of mucinous cystadenocarcinoma and mature cystic teratoma. The rate of agreement between the tissue pattern predicted by USG and the histopathological diagnosis was 25%. Matching rate for dermoid cysts was 37.3%. Immature teratoma (G1) could not be predicted preoperatively, but a combination of mucinous cystadenocarcinoma (G1) and mature cystic teratoma was diagnosed as ovarian cancer and a low malignant potential case by some gynecologists. MRI was useful for the diagnosis of dermoid cyst. On the other hand, it was quite difficult to diagnose the tumors as malignant by MRI.

Conclusions: USG can make images at a given cross-section in real-time, and follow the time course of their changes. On the other hand, MRI may display excellent tissue contrast to target tissues and delineate more accurate morphological changes. The combined use of USG and MRI may further improve the diagnosis of ovarian tumors.

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Key words: Ultrasound tomography, MRI, ovarian tumor, pregnancy, dermoid cyst

Introduction

The widespread use of ultrasonography (USG) has led to an increase in the incidental detection of ovarian masses in early pregnancy. It has been reported that 5% of patients may have ovarian tumors detected by ultrasound examination in early pregnancy[1]. Among them, ovarian cysts of secretory accumulation account for 80-90% and most of them disappear by the 16th week of pregnancy. Therefore, they can be followed-up without treatment if asymptomatic[1].

Although many ovarian tumors detected during pregnancy are benign, 2-3% of them are reported to be malignant[2]. In the late term of pregnancy, the operation for ovarian tumor is not only difficult because of the size of the growing uterus, but the risk of threatened preterm birth increasing. So it is important to make a correct diagnosis of ovarian tumors if suspected during the course of pregnancy. Since the sonographic features of dermoid cyst, one of the most common tumors, are varied, it is difficult to predict its histological type by USG alone. Magnetic resonance imaging (MRI), as reported to be superior to USG in determining the histological properties , may be essential for the diagnosis of

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ovarian tumors, and should be performed as a routine work-up after USG. However, proper information on the tissue pattern of ovarian tumors by preoperative imaging and its association with post-operative histological findings in pregnancy was not well described.

Therefore, we aim to investigate whether it is possible to predict the histological type of ovarian tumors by the preoperative imaging (USG and MRI) findings of tumors in women who had undergone surgery for pregnancy-associated ovarian tumors.

Methods

Between July 1997 and December 2006, maternal ovarian masses were detected by USG examination in 48 pregnant women and MRI was also performed subsequently in these women in our department of Nagasaki University Hospital. Operation was performed in 18 cases, while the remaining 30 cases were only observed because masses were small and/or disappeared. Therefore, all medical records, e.g. timing and findings of USG and/or MRI, indications, timing and methods of operation and pathologic findings were examined for 18 pregnant women who visited our hospital during a variable timing of pregnancy.

All ultrasound examination was performed by an expert gynecologist in ultrasound image. Ten board-certified gynecologists with 6 to 20 years of experience (Dr. A to J) viewed retrospectively classified all tumors based on an echo-pattern classification of ovarian tumors (Fig. 1) and predicted their histological types.

For MRI, axial T1- and T2- weighted images (WI), and axial fat-saturated T1WI, and sagittal T2WI were obtained. All MRI images were examined and interpreted by an experienced radiologist who predicted the histological type without any prior ultrasound information. Ultrasonographic and MRI findings were subsequently compared with the histopathological findings.

We performed operations when we diagnosed the ovarian mass was neoplasm (ovarian tumor).

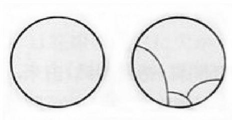
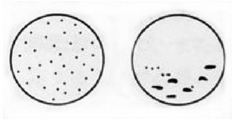
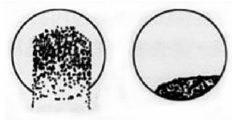
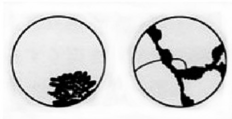
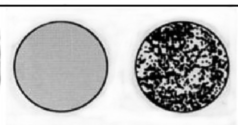
pattern			explanation
I		cystic pattern (no echo in the tumor)	It is unregardless of the presence of septum. Septum's edge is smooth.
II		cystic pattern (some shadow in the tumor)	It is unregardless of the presence of septum. Septum's edge is smooth. Punctation or liner echo is in the tumor.
III		mixed pattern	Solid portion is in the tumor. Edge of solid part is smooth. Sometimes, there is acoustic shadow
IV		mixed pattern(cystic lesion> solid lesion)	Tumor has thick and irregular septum or solid part. Solid part's shape is irregular and edge is rough.
V		mixed pattern(cystic lesion< solid lesion)	Almost of the tumor is solid part. Solid part's echo is homogenous or heterogenous
VI		solid pattern	Tumor is filled of solid part Echo pattern of the tumor inside is homogenous or heterogenous
unclassified			

Figure 1. Shows echo-pattern classification of ovarian tumors.
Ovarian tumors are classified into types I through VI according to the presence or absence of septa and a solid component, and internal echogenicity. Ovarian tumors have different morphological types, and these types constitute the criteria for their diagnosis by Ultrasonography.

Results

Table 1 shows the clinical characteristics of 18 pregnant women who had surgery after imaging diagnosis of ovarian tumors. The mean age of these women was 27.4 years (range, 18-34 years). Fourteen were noted to have ovarian tumors on USG during pregnancy who first visited our department at a mean of 10 weeks and 4 days of pregnancy (from pre-pregnancy to 21 weeks and 2 days). At the preoperative diagnosis, two patients had ovarian masses without a pregnancy-associated reduction in their size, 1 had suspected ovarian tumor pedicle torsion, and 15 had ovarian tumors (neoplasms).

Table 2 shows the operation procedures and the results of pathological diagnosis. All 18 women underwent surgery at a mean gestational age of 15 weeks and 1 day (from 6 weeks to 25 weeks and 0 day). Five women underwent open abdominal surgery, 12 had laparoscopic surgery, and one had laparoscopic surgery with conversion to open abdominal surgery. Histopathological diagnoses were parovarian cyst (n=1), simple cyst (n=1), mucinous cystadenoma (n=3), a combination of mucinous cystadenoma and mature cystic teratoma (n=1), mature cystic teratoma (n=9), hemorrhagic lutein cyst (n=1), immature teratoma (Grade1) (n=1), a combination of mucinous cystadenocarcinoma (G1) and mature cystic teratoma (n=1). Thus malignant tumors were seam in 2 patients (case 17 and 18).

Table 3 shows the results of classification of the US images according to the echo-pattern classification of ovarian tumors. All gynecologists (Dr. A to J) classified cystic masses (cases 1 and 2) as type I or II. On the other hand, dermoid cysts (cases 7 through 15), the most common ovarian tumors during pregnancy, showed various ultrasound images (Fig. 2). Dermoid cysts were most commonly (53/110 or 48.2%) classified as the type IV echo pattern, and 62.9% (69/110) as types IV-VI, which were considered to have a high probability of malignancy. Malignant tumors (cases 17 and 18) were frequently classified as type IV or VI.

Table 1. Patient's characteristics

Case	age	gravid	parity	Timing of ovarian mass detected	First visited our department(weeks +days)	Preoperative diagnosis
1	20	0	0	Post	12+6	rt.OM (no interval decrease)
2	27	1	1	Pre	15+5	rt.OM (no interval decrease)
3	22	1	1	Post	10+1	rt.OT (M)
4	25	0	0	Post	13+1	lt.OT (M)
5	28	0	0	Post	21+2	rt.OT (M)
6	26	0	0	Post	5+0	rt.OT (D)
7	32	1	1	Post	10+6	lt.OT (D)
8	30	1	1	Post	9+1	lt.OT (D)
9	30	1	1	Pre	11+1	rt.OT (D)
10rt.	28	0	0	Post	7+2	rt.OT (D)
10lt.	28	0	0	Post	7+2	lt.OT (D)
11rt.	18	0	0	Post	5+3	rt.OT (D)
11lt.	18	0	0	Post	5+3	lt.OT (D)
12	33	1	1	Post	6+3	rt.OT (D)
13	32	1	0	Post	14+2	lt.OT (D)
14	28	1	1	Pre	8+4	lt.OT (D)
15	32	1	0	Post	9+6	rt.OT (D)
16	22	0	0	Post	6+0	Acute abdomen, torsion of pedicles
17	26	1	1	Post	14+0	rt.OT (D)
18	34	1	1	Pre	Pre	lt.OT (interval increased)

rt.: right ovary lt.: left ovary
Pre: pre gestation Post: post gestation
OM: ovarian mass OT: ovarian tumor
M: mucinous cystadenoma D: Dermoid cyst

Table 2. Operation procedure and results of pathological diagnosis

Case	timing of operation	Operation procedure	Pathological diagnosis
1	16+5	※	paraovarian cyst, right ovary
2	16+6	LAPARO	simple cyst, right ovary
3	18+4	LAPARO	mucinous cystadenoma, right ovary
4	16+0	LAPARO	mucinous cystadenoma, left ovary
5	25+0	Opening adnexectomy	mucinous cystadenoma, right ovary
6	13+5	LAPARO	mucinous cystadenoma and mature cystic teratoma, right ovary
7	13+1	LAPARO	mature cystic teratoma, left ovary
8	17+2	LAPARO → OPEN	mature cystic teratoma, left ovary
9	13+6	LAPARO	mature cystic teratoma, right ovary
10rt.	13+0	LAPARO	mature cystic teratoma, right ovary
10lt.	13+0	LAPARO	mature cystic teratoma, left ovary
11rt.	13+2	OPEN	mature cystic teratoma, right ovary
11lt.	13+2	OPEN	mature cystic teratoma, left ovary
12	14+6	LAPARO	mature cystic teratoma, right ovary
13	15+3	LAPARO	mature cystic teratoma, left ovary
14	15+3	LAPARO	mature cystic teratoma, left ovary
15	13+1	LAPARO	mature cystic teratoma, left ovary
16	6w	LAPARO	lutein cyst with hemorrhage, left ovary
17	15+3	LAPARO	immature teratoma, G1, right ovary
18	16+4	OPEN	mucinous cystadenocarcinoma(G1) and mature cystic teratoma, left ovary

※ Laparoscopic-assisted paraovariancystectomy
rt.: right ovary lt.: left ovary
OM: ovarian mass OT: ovarian tumor
M: mucinous cystadenoma D: Dermoid cyst
OPEN: opening ovarian tumorectomy
LAPARO: laparoscopic-assisted ovarian tumorectomy

Table 3. Classification of the ultrasonographic images (echo pattern classification)

	A	B	C	D	E	F	G	H	I	J
1	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ
2	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅱ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ
3	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅱ	Ⅱ	Ⅰ	Ⅰ	Ⅰ
4	Ⅳ	Ⅰ	Ⅳ	Ⅳ	Ⅰ	Ⅰ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
5	Ⅳ	Ⅳ	Ⅰ	Ⅴ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
6	Ⅳ	Ⅰ	Ⅳ	Ⅳ	Ⅰ	Ⅳ	Ⅰ	Ⅳ	Ⅳ	Ⅳ
7	Ⅳ	Ⅲ	Ⅳ	Ⅳ	Ⅳ	Ⅱ	Ⅳ	Ⅳ	Ⅳ	Ⅲ
8	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
9	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
10rt.	Ⅳ	Ⅲ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ
10lt.	Ⅲ	Ⅲ	Ⅰ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ	Ⅲ
11rt.	Ⅲ	Ⅲ	Ⅱ	Ⅴ	Ⅳ	Ⅳ	Ⅲ	Ⅳ	Ⅲ	Ⅳ
11lt.	Ⅳ	Ⅳ	Ⅲ	Ⅳ	Ⅲ	Ⅲ	Ⅳ	Ⅳ	Ⅳ	Ⅲ
12	Ⅱ	Ⅴ	Ⅳ	Ⅴ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅱ
13	Ⅳ	Ⅲ	Ⅳ	Ⅴ	Ⅱ	Ⅲ	Ⅲ	Ⅵ	Ⅵ	Ⅲ
14	Ⅵ	Ⅱ	Ⅴ	Ⅵ	Ⅱ	Ⅵ	Ⅲ	Ⅲ	Ⅵ	Ⅵ
15	Ⅴ	Ⅴ	Ⅳ	Ⅳ	Ⅳ	Ⅲ	Ⅳ	Ⅴ	Ⅱ	Ⅴ
16	Ⅵ	Ⅴ	Ⅴ	Ⅴ	Ⅱ	Ⅴ	Ⅴ	Ⅱ	Ⅴ	Ⅴ
17	Ⅵ	Ⅲ	Ⅵ	Ⅵ	Ⅱ	Ⅳ	Ⅵ	Ⅵ	Ⅵ	Ⅵ
18	Ⅳ	Ⅳ	Ⅰ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ

A-J means the individual person who classified the shown ultrasonographic images.

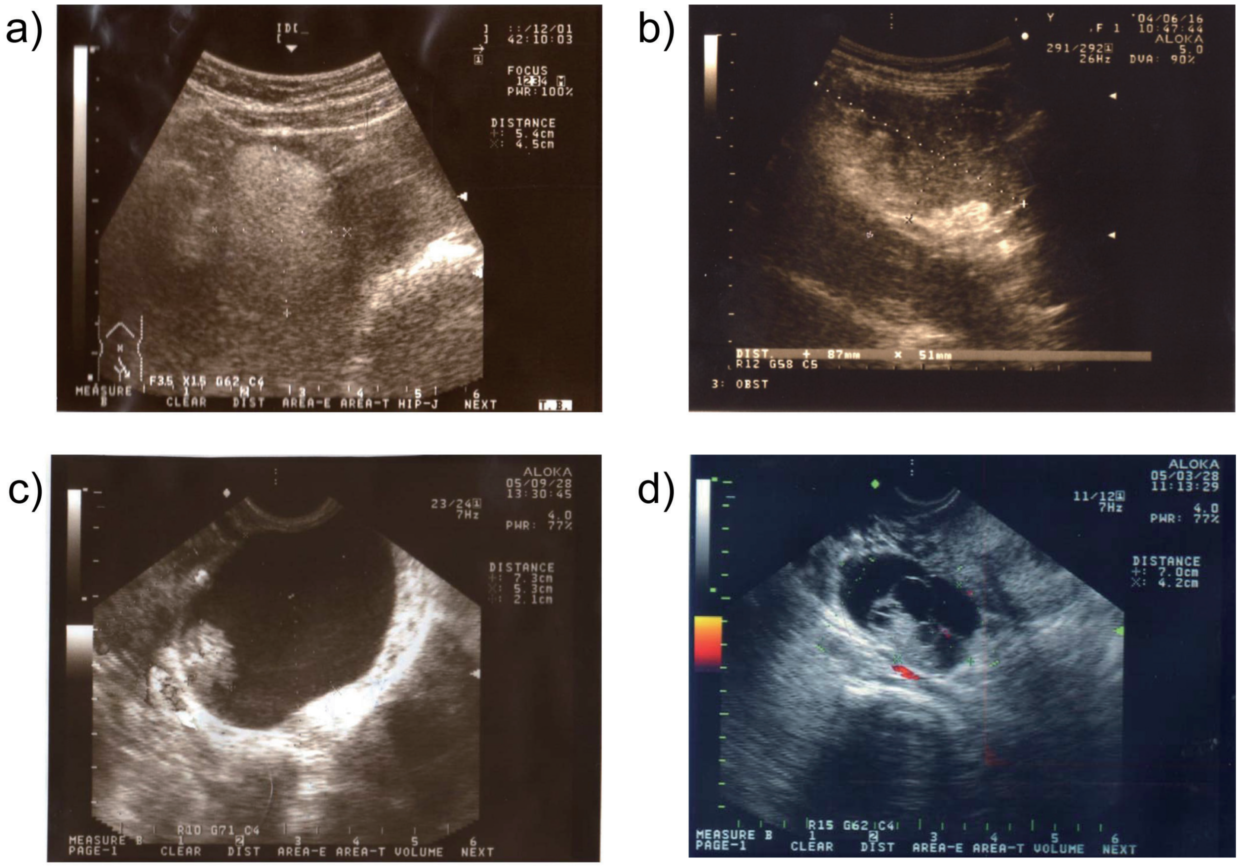


Figure 2. Shows variable images of dermoid cysts by USG.
a) case 14 (8weeks and 4days), b) case 13 (14weeks and 2days), c) case 9 (11weeks and 1day), d) case 8 (9weeks and 1day).

Table 4 shows the histological types predicted by US. The rate of agreement between the histological type predicted by USG and the histopathological diagnosis was 25 % (50/200), and that for dermoid cyst alone (cases 7-15) was 37.3% (41/110). Immature teratoma (G1) (case 17 of Table 2) could not be predicted preoperatively, but a combination of mucinous cystadenocarcinoma (G1) and mature cystic teratoma (case 18 of table 2) was diagnosed as ovarian cancer and a low malignant potential case by six and two gynecologists, respectively.

Table 5 shows MRI diagnoses. MRIs were performed at a mean of 13 weeks and 5 days of pregnancy (6 weeks to 21weeks and 6 days). MRI was indicated in 12 patients showing a solid area in the tumor and in 6 with cystic masses without reduction in their size during pregnancy.

MRI images were diagnosis by only one radiologist. So it was difficult to compare with ultrasonographic and MRI findings. But all dermoid cysts (cases 7 -15), the tumor showing a solid area and the most common ovarian tumors during pregnancy, were correctly diagnosed.

On the other side, the case 17 of Table 2 with a final diagnosis of immature teratoma (G1) was diagnosed as dermoid cyst, and the case 18 of Table 2 with a final diagnosis of mucinous cystadenocarcinoma (G1) and mature cystic teratoma was diagnosed as mucinous cystadenoma and dermoid cyst by MRI.

In the case of cystic mass, MRI demonstrated the shape of the mass and the character of fluid in the cyst, but couldn't predict the histological type.

Figure 3 represents USG and MRI findings of case 9. A solid projection into the tumor cavity on US images was hyperintense on T1WI and T2WI, and showed a diminished signal intensity on fat-suppressed T1WI, indicating that it represented a fat component. Thus, the preoperative diagnosis was right ovarian tumor (dermoid cyst). At 13 weeks and 6 days of pregnancy, laparoscopic-assisted ovarian tumorectomy (abdominal wall-lifting procedure) was performed. Gross examination of the resected specimen revealed a cyst containing hair and fat, leading to a histopathological diagnosis of mature cystic teratoma of the right ovary (dermoid cyst).

The patient (case 17) was noted to have an ovarian mass on ultrasound examination at a local hospital during pregnancy, and was referred to our department. USG showed a

Table 4. The histological types predicted by ultrasound tomography

	A	B	C	D	E	F	G	H	I	J
1	artifact	s	s	s	s	s	s	lutein/s	s	s
2	artifact	s	s	***simple cyst***	D	s	s	s	s	s
3	s	s	s	s	s	s	s	s	s	s
4	LPM	***m***	***m***	Ca	s	***m***	D	s,LPM	***m***	s,Ca
5	m,LPM	m,LPM	***m***	Ca	***m***	m,LPM	m,Ca	Ca	***m***	m,Ca
6	m,LPM	m	m	Ca	m	m	OHSS	Ca	m	lutein/m
7	LPM	s,LPM	s,LPM	Ca	***D***	choco	D/m,Ca	LPM	Ca	s
8	LPM	m,LPM	m	Ca	m,LPM	Ca	m,Ca	***D***	Ca	m/m,Ca
9	LPM	s,LPM	s	Ca	Ca	Ca	D/m,Ca	LPM	Ca	S,LPM
10rt.	LPM	***D***	lutein	Ca	m,Ca	Ca	Ca	lutein	Ca	***D***
10lt.	LPM	***D***	lutein	Ca	***D***	choco	Ca	lutein	Ca	lutein
11rt.	***D***	***D***	***D***	***D***	OV	***D***	Ca	Ca	s,Ca	Ca
11lt.	***D***	***D***	***D***	***D***	***D***	s	Ca	Ca	s,Ca	***D***
12	***D***	D/Ca	m	***D***	CLH	***D***	***D***	***D***	***D***	choco
13	choco	s,LPM	choco	***D***	***D***	***D***	***D***	Ca	***D***	choco/D
14	***D***	***D***	***D***	***D***	***D***	***D***	***D***	***D***	choco	***D***
15	LPM	D/Ca	***D***	***D***	s,Ca	***D***	Ca	Ca	***D***	choco
16	D	fibroma	D	D	***CLH***	D	D	D	D	D
17	D	D	D	D	D	D	myoma	D	choco	choco
18	LPM	m,LPM	lutein	Ca	m,Ca	choco	Ca	Ca	m,Ca	Ca

s: serous cystadenoma m: mucinous cystadenoma
LPM: low malignant potential D: Dermoid cyst
choco: chocolate cyst lutein: lutein cyst
s, LPM: serous cystic tumor of low malignant potential
m, LPM: mucinous cystic tumor of low malignant potential
OV: ovarian bleeding
CLH: corpus luteum hematoma
a/b: a or b
■ : a case of agreement

Table 5. MRI diagnosis

Case	timing of MRI (weeks+days)	MRI diagnosis
1	15+1	ovarian cystic mass
2	16+3	ovarian cystic mass
3	16+4	rt ovarian cystic mass
4	14+3	lt. ovarian multilocular cyst
5	21+6	mucinous cystadenoma susp.
6	12+6	multicystic mass with Dermoid cyst
7	11+6	Dermoid cyst
8	15+3	Dermoid cyst
9	12+3	Dermoid cyst
10rt.	11+5	Dermoid cyst, right ovary
10lt.	11+5	Dermoid cyst, left ovary
11rt.	13+0	Dermoid cyst, right ovary
11lt.	13+0	Dermoid cyst, left ovary
12	13+4	Dermoid cyst
13	14+4	Dermoid cyst
14	14+3	Dermoid cyst
15	11+3	Dermoid cyst
16	6w	lt. ovarian cyst with hemorrhage
17	15+0	Dermoid cyst
18	12+4	Dermoid cyst and mucinous cystadenoma

non-septate solid mass and MRI revealed a fat component, leading to a diagnosis of right ovarian tumor (dermoid cyst). The patient underwent laparoscopic-assisted ovarian tumorectomy at 15 weeks and 3 days of pregnancy. On gross examination, the resected specimen showed no overt malignant features, and was histopathologically diagnosed as immature teratoma (G1) of the right ovary. Right adnexectomy was performed at 18 weeks and 2 days of pregnancy. The resected ovary showed no evidence of residual tumor.

Discussion

We demonstrated for the first time that the histopathological predictions of ovarian tumors by USG in pregnant women carried an agreement of 25% with the histopahtological examinations of the resected specimen.

In the case of cystic mass, both USG and MRI showed the shape of the mass and the character of the fluid in the cyst, but it was difficult to distinguish between ovarian cysts (simple cysts) and tumors (neoplasm) by only one examina-

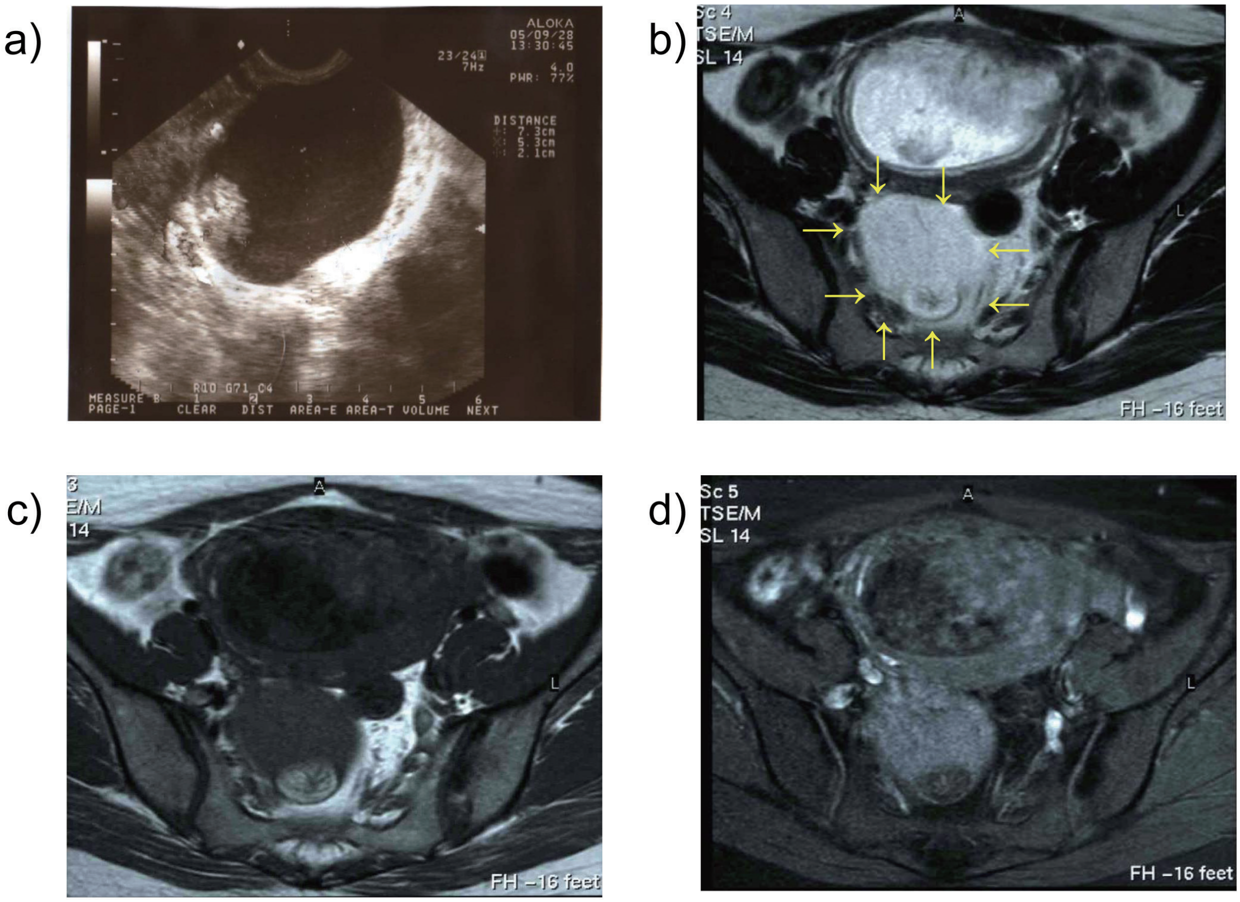


Figure 3. Shows USG and MRI findings of case 9.
a) USG, b) MRI T2WI, axial, c) MRI, T1WI axial, d) MRI, T1WI fat saturation, axial.

tion. Following their size changes by USG were needed.

The rate of agreement between the histological type predicted by USG for dermoid cyst alone was 37.3%. On the other hand, all dermoid cysts were correctly predicted by MRI. It was useful to use MRI for the diagnosis of dermoid cyst. On the other hand, it was difficult to diagnose the tumors as malignant by both MRI and USG.

Using small number of pregnant women, our current study at least indicated that combined use of USG and MRI may be useful in clinical practice to identify and predict the histologic type of ovarian tumors during the course of pregnancy.

The use of ultrasound examination in early pregnancy has resulted in an increased frequency of detecting pregnancy-associated ovarian masses. When ovarian enlargement is detected, it is important to distinguish between ovarian cysts (simple cysts) and tumors (neoplasms). Among ovarian cysts in early pregnancy, corpus luteum and theca-lutein cysts are common, and can be followed-up without treatment. Masuzaki followed-up 58 patients with ovarian masses observed in early pregnancy, and reported that ovarian cysts did not exceed 10 cm in diameter, and shrunk or disappeared by the 16th week of pregnancy, whereas ovarian tumors did not show a tendency to shrink during pregnancy[1]. Lavery et al. performed ultrasound in 3,918 women in early pregnancy, and reported that ovarian enlargement was observed in 8.8% of the women by the 5th week of pregnancy, and in as few as 0.35% (ovarian masses disappeared in 96%) at 16-20 weeks of pregnancy[3].

Although rare, ovarian tumors may undergo torsion of the pedicle requiring emergency surgery, may complicate the passage of the fetus during labor, and may have a malignant potential. Studies have reported that, as the uterus grows during pregnancy, ovarian tumors associated with pregnancy move away from their pre-pregnancy location; thus, the incidence of pedicle torsion, hemorrhage, and rupture increases to 3-15%[4-7]. Other studies have reported that most ovarian tumors are benign, but 2-8% are malignant or borderline malignant[2,8]. In our case, two ovarian tumors (2/18 or 11.1%) were malignant which is almost similar to the published report.

As a rule, when an ovarian tumor is diagnosed, it is resected even during pregnancy. Open abdominal surgery used to be performed at 15 weeks of gestation or later. However, with the increased use of laparoscopic surgery, tumor resection has been performed at an early gestational stage when a satisfactory surgical field is ensured. We performed open surgery in one patient (case 11, 13 weeks and 2 days of pregnancy) who had a large tumor growing above the level of the xiphoid process, and in another patient (case 18, 16 weeks and 4 days of pregnancy) with a history of two previous surgeries and adhesions. In case 8 (17 weeks and 2 days of pregnancy), we attempted laparoscopic surgery, but the tumor was incarcerated in the pouch of Douglas due to pregnancy-associated uterine enlargement, and could not be lifted even by transvaginal manipulation; therefore, we converted to open surgery. Laparoscopic surgery was successfully performed in all patients who were not more than 16 weeks pregnant. It is necessary to make an earlier, more accurate, qualitative diagnosis of the tumor. We need to qualitatively diagnose ovarian tumors as early and accurately as possible.

Ultrasonography can generate images at a given cross-section in real-time, and follow the time course of their changes. The presence or absence of septa, properties of echo signals inside the tumor, and presence or absence of a solid component constitute the criteria for determining the benign or malignant nature of ovarian tumors as shown in Figure 1. Under the echo-pattern classification, the probabilities of malignancy and borderline malignancy in ovarian tumors vary according to echo patterns, and are reportedly less than 3% for types I, II, and III, 53% for type IV, about 70% for type V, and about 31% for type VI. However, the sonographic features of the most common dermoid cyst were mostly variable, and the results of evaluation (echo pattern classification) of the same ultrasound image were different. Because of this variation of echo-pattern in our study, the overall rate of agreement between ultrasound and pathological diagnoses was only 25%. We think that this less agreement cannot be helped in the clinical settings.
We believe that use of color Doppler may give us further information to identify malignant tumors. We need further study to resolve this issue.

MRI provides excellent tissue contrast, and cannot only assess morphological change but can also delineate tissue structures. In this study, MRI was superior to USG for diagnosis of dermoid cyst. No conclusion has been reached on fetal safety, but no adverse effects of MRI on the fetus have been reported. At present, MRI is advised to perform as a preoperative work-up except during the period of organogenesis in early pregnancy[9,10].

Noninvasive examination techniques such as USG and MRI have been evolved. However, one cannot palpate or sample ovarian tumors directly from outside the body, and two patients with malignant tumors encountered in our department showed no findings suggestive of malignancy before surgery. We consider that it is necessary to perform surgery even during pregnancy to establish the diagnosis.

In conclusion, we suggest that it may possible to predict the histological type of ovarian tumors by preoperative USG and MRI findigns. USG can make images at a given cross-section in real-time, and follow the time course of their changes. On the other hand, MRI may display excellent tissue contrast to target tissues and delineate more accurate morphological changes. We propose that the combined use of USG and MRI may be useful for the diagnosis of ovarian tumors even during pregnancy. Further studies are needed to support our current findings.

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