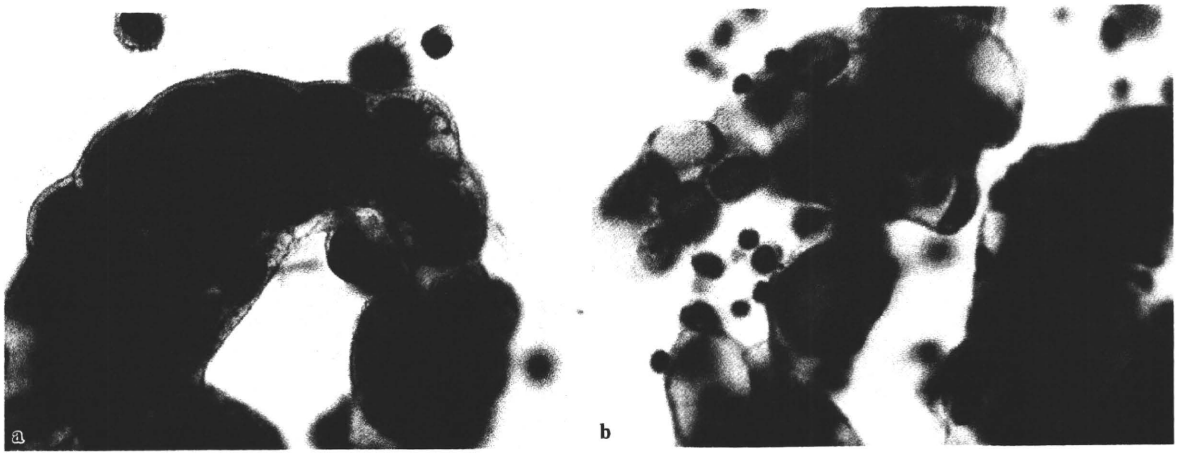

図3　漿液性腺癌（Papanicolaou 染色）　a：辺縁は丸みを帯び，比較的小型均一，円形～類円形の核，核クロマチンは細顆粒状，1～複数個の核小体を有し，好塩基性の胞体は乏しく，N/C 比は極めて高い．b：乳頭状集塊の中央に psammoma body が観察される．

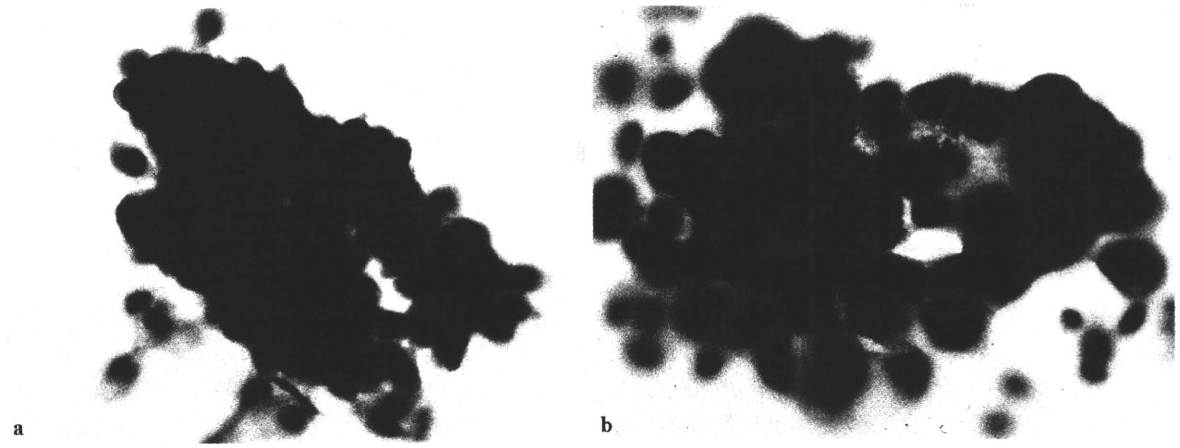

図4　類内膜腺癌（Papanicolaou 染色）　a：大小不同の異型細胞が重積性集塊を形成し，腺腔がみられる．b：核は円形～類円形，核クロマチンは顆粒状，核小体が観察され，N/C 比は高い．

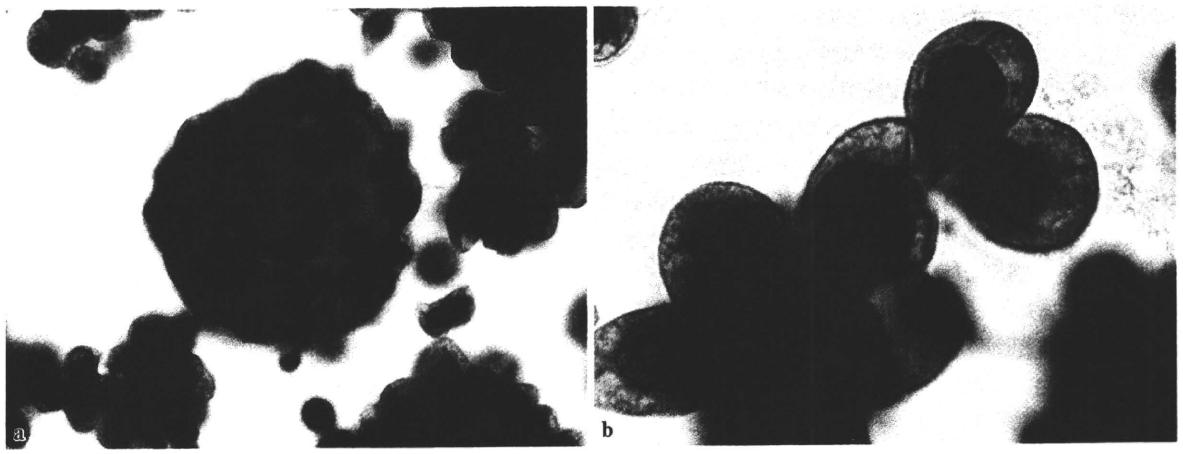

図5　明細胞腺癌（Papanicolaou 染色）　a：ミラーボール状の集塊，乳頭状集塊がみられる．b：特徴的な hobnail 状細胞が観察される．

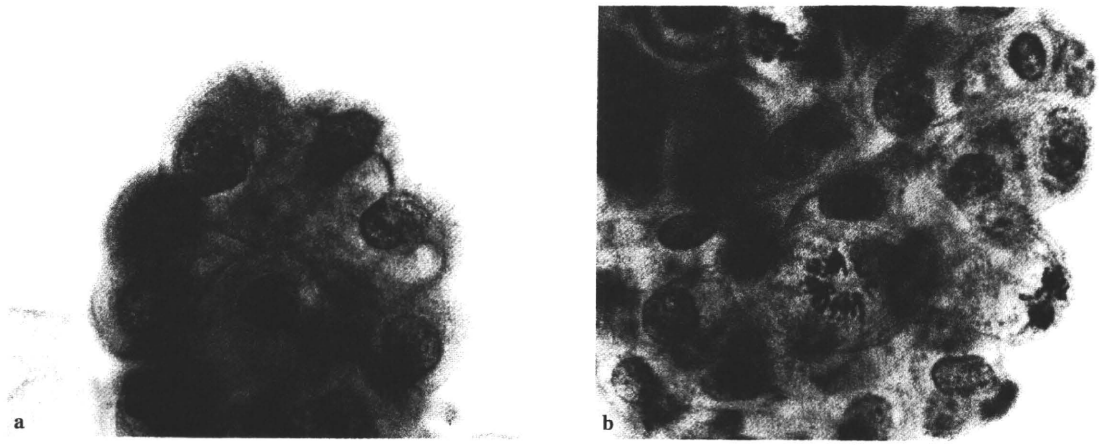

図6　粘液性腺癌（Papanicolaou染色）　a：粘液産生を有する異型細胞が小集塊を形成している．b：核は円形～類円形，核クロマチンは細顆粒状，核縁肥厚，核小体が観察される．細胞境界は不明瞭，胞体は豊富でライトグリーン好性で，核分裂像が散見される．

切な腹腔内洗浄液の採取と標本を作製し，臨床側と検査側の密接な連携のもとに悪性細胞の有無を慎重に判定する．

ま と め

婦人科悪性腫瘍における腹腔内洗浄細胞診の採取法，臨床的意義および細胞所見について治療，予後の面から有用性を検討した．

病変が頸部に限局する子宮頸癌では，腹腔内洗浄細胞診陽性例はみられないが，腺癌では注意深い検索が必要である．病変が子宮内に限局する子宮体癌では，経卵管的に腹腔内洗浄細胞診が陽性となり，付属器転移や漿膜浸潤例ではさらに陽性率が高い．病変が卵巣に限局する卵巣癌の腹腔内洗浄細胞診陽性例は予後不良である．したがって，予後不良例には効果的な薬剤の選択，追加治療の可否を決定することが，治療成績の改善や患者のQOLの面から必要である．

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MRI of Endometriotic Cysts in Association With Ovarian Carcinoma

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OBJECTIVE. Although mural nodules are considered to be the most important hallmark in the recognition of ovarian cancers accompanied with endometriotic cysts, benign neoplasms and even inflammatory diseases can show similar MRI findings. We sought to clarify the MRI characteristics of malignancy accompanied with endometriotic cysts of the ovary.

MATERIALS AND METHODS. Contrast-enhanced MRI was performed and endometriosis was pathologically confirmed in 49 patients with endometriotic cysts displaying mural nodules. Malignancy was pathologically diagnosed in 33 patients and benignity, in 16. Clinical data including patient age and MRI findings in terms of the size of the endometriotic cysts, number of loculi, presence of shading of the cysts, size of the mural nodules, signal intensity of the mural nodules on T1- and T2-weighted images, and contrast enhancement of the mural nodules were retrospectively reviewed. Statistical analysis of each parameter used the Mann-Whitney *U* test.

RESULTS. The mean age of the patients and mean size of the endometriotic cysts were significantly higher in patients with a malignant condition than in those with a benign condition. Contrast enhancement of the mural nodules was observed in 97% of malignant and 44% of benign tumors. The size of the mural nodules was significantly larger in patients with a malignant condition than in those with a benign condition. Differences in size between the bilateral diseases, multilocularity, existence of shading, and the signal intensities of mural nodules were not significantly different between the malignant and benign conditions.

CONCLUSION. Endometriotic cysts with enhanced mural nodules are not always complicated with malignancy. In elderly patients, the presence of large enhanced nodules on large endometriotic cysts is more likely to indicate malignancy.

Keywords: endometriosis, endometriotic cysts, MRI, ovarian carcinoma, ovary

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The number of patients with endometriosis is increasing in the developed countries. In addition, the number of patients desiring conservative observation is also increasing because a higher number of nulliparous women are in their 30s than before. On the other hand, endometriotic cysts have drawn attention as a potential source of ovarian carcinomas [1–3]. Several clinical and imaging risk factors have been reported, such as age of more than 40 years, large cyst size, lack of shading on MRI, and so on [4–6]. Investigators have also reported that patients with endometriotic cysts have decreased dysmenorrhea after malignant transformation occurs [5]. Of these findings, enhancement of mural nodules seems to be the most valuable imaging finding [6, 7]; however, benign conditions with this finding have been also reported [8–14].

The purpose of this study was to clarify the MR findings of ovarian cancer in association with endometriotic cysts by comparing the findings in benign and malignant lesions in detail.

Materials and Methods

From a review of our PACS for the period of April 1997 to November 2006, we found 71 cases with findings that could be suspicious for ovarian cancer in association with endometriosis. Patients were initially selected for entry in this study by gynecologists in an outpatient clinic. We picked primary candidates who had cystic adnexal masses with some solid parts on transvaginal or transabdominal ultrasound by reviewing the order form for the pelvic MR examination. Patients with adnexal masses that showed MR characteristics of endometriotic cysts and mural nodules or eccentric cyst-wall thickening were included as secondary candidates and a contrast study was added. Our MR criteria for the endometriotic cysts were hyperintense masses with a thick wall or septa on fat-saturated T1-weighted images and at least one of the following findings:

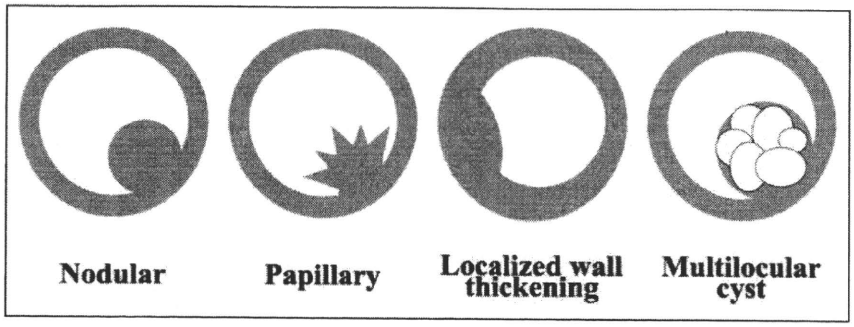


Fig. 1—Illustration shows morphologic classification of protruded cyst wall. We classified morphologic pattern of protruded cyst wall into four types: nodular, papillary, localized wall thickening, and multilocular cyst.

shading on T2-weighted images, multilocular cyst, or adhesion to the surrounding organ. Shading is a characteristic finding of endometriotic cysts, as reported by Nishimura et al. [15], and is defined as a centrally or peripherally located low-intensity area in the hyperintense cyst. The mural nodules were defined as focal bulging of the cyst wall toward the center of the cyst at an acute angle. For inclusion in the study, the secondary candidates were required to have MR characteristics of both the endometriotic cysts and mural nodules or eccentric cyst-wall thickening. Surgical removal was performed in 55 of 66 secondary candidates; however, ectopic endometrial tissue was not observed in the surgical specimen in six cases. Therefore, 49 cases with histopathologically confirmed ovarian endometriotic cysts were included in this study.

MR examinations were performed using 1.5-T superconducting units (Gyroscan, Philips Healthcare). Images were obtained with a phased-array body coil in all patients. Butyl scopolamine (Buscopan, Boehringer Ingelheim) was given intramuscularly just before the examination to reduce bowel peristalsis. Axial T1-weighted images, T2-weighted images, and fat-saturated T1-weighted images were obtained. Contrast enhancement was also performed with IV administration of 5 mmol of gadopentetate dimeglumine (Magnevist, Bayer HealthCare). The field of view (FOV) was 28 cm in all sequences except a 3D dynamic contrast study.

T1-weighted images were obtained with a spin-echo sequence (TR range/TE range, 340–545/11–20; slice thickness, 4–10 mm; intersection gap, 0.4–2 mm; 2–4 excitations), and T2-weighted images were obtained with a fast spin-echo sequence (TR/TE, 1,800/100; echo-train length, 16; slice thickness, 4–10 mm; intersection gap, 0.4–2 mm; 2 excitations). Fat-saturated T1-weighted images were obtained using a spectral presaturation with inversion-recovery sequence (425–680/10–12); the slice thickness and intersection gap were the same as those used for T1-weighted imaging before contrast administration with 2–3 excitations.

After administration of contrast material, fat-saturated T1-weighted images were obtained using the same parameters as those used before contrast enhancement in six patients, a 2D dynamic contrast study with subtraction with turbo field-echo imaging (12/4.6; slice thickness, 8–10 mm; 4 or 6 planes; 6 excitations; temporal resolution, 31 milliseconds) was used in 34 patients, and a 3D dynamic contrast study with subtraction with T1 high-resolution isotropic imaging (4.3/2.0; FOV, 40 cm; slice thickness, 4 mm with 2-mm overlap; 40–80 planes; 1–2 excitations; temporal resolution, 20–40 seconds) was performed in nine patients.

MR findings were retrospectively reviewed without the knowledge of surgical or pathologic findings by two radiologists in consensus who were familiar with gynecologic MRI. They evaluated the size and nature of the endometriotic cysts: whether disease was unilateral or bilateral, the ratio of the maximum diameter of the affected cyst to the contralateral cyst, whether cysts were unilocular or multilocular, and the presence of shading. A patient was considered to have bilateral disease only when the contralateral ovary had another lesion that met our criteria for endometriotic cysts. The ratio of the maximum diameter of the affected cyst to the contralateral cyst was calculated only when the patient had bilateral disease. In other words, we excluded the cases with unilateral disease from that statistical analysis.

We also evaluated the size and nature of the mural nodules: shape, the maximum diameter, signal intensity compared with the outer myometrium on T1- and T2-weighted images, and contrast enhancement. We classified the morphologic pattern of the protruded cyst wall into four types (Fig. 1). The first type was the nodular type in which one or more mural nodules had a smooth margin over the entire surface of the mural nodules. The second type was the papillary type in which one or more mural nodules had a papillary surface. The third type was multilocular cysts in which the mural nodules were composed of cysts with thin septa. The fourth type was localized wall thickening in which the eccentric cyst-wall thickening was at an obtuse angle. The localized wall thickening type was slightly different from the other three types, although we included cysts of this type in our study because cyst-wall thickening has been reported as a sign for malignant cystic adnexal masses [16].

Statistical analysis between benign and malignant diseases was also performed using the Mann-Whitney *U* test (Prism 4, GraphPad Software) for Macintosh (Apple Computer) to evaluate for differences in patients' age, maximum cyst diameter, and type of protruded cyst wall.

Results

The final pathologic diagnoses are summarized in Table 1. Thirty-three patients had a malignant condition (Fig. 2) and 16, a benign condition (Fig. 3). Only one diagnosis in the benign category was a mucinous cystadenoma, and the others were not associated with neoplasms. In the malignant group, four cases were borderline epithelial neoplasms, 28 were carcinomas, and the remaining one was adenosarcoma. The histologic subtype was se-

TABLE 1: Histopathologic Diagnosis of the Cases

Histopathology	No. of Cases
Malignant condition	
Borderline malignancy	
Serous	2
Mucinous	1
Endometrioid	1
Adenocarcinoma	
Serous	5
Clear cell	8
Endometrioid	11
Mixed	3
Undifferentiated carcinoma	1
Adenosarcoma	1
Benign condition	
Benign neoplasm	
Mucinous cystadenoma	1
Endometriosis with inflammation	1
Pure endometriosis	14

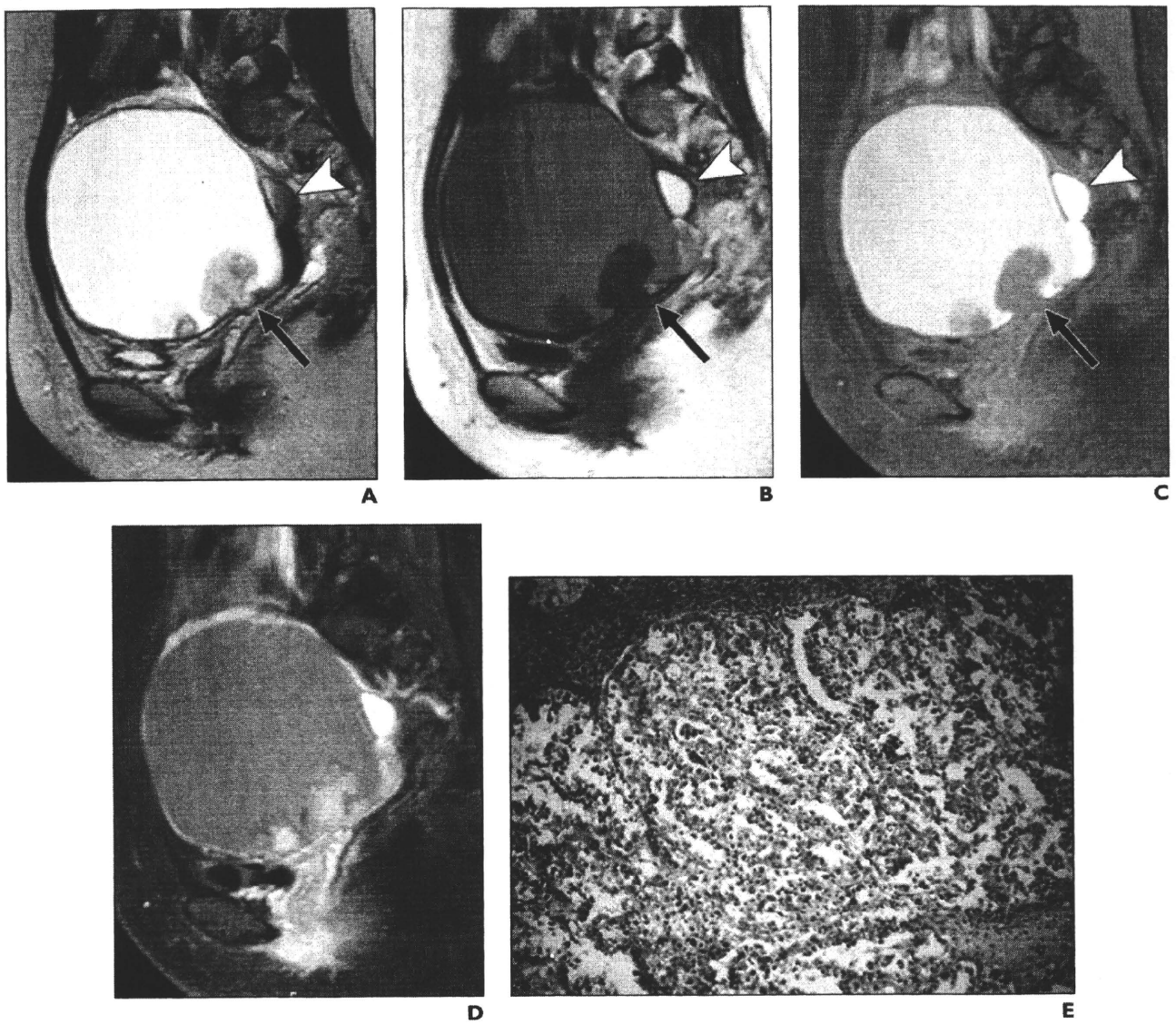
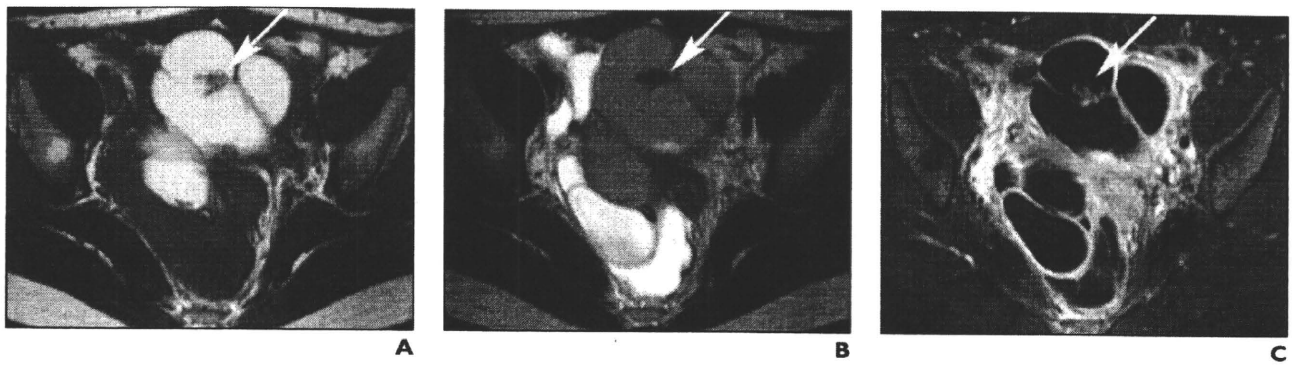


Fig. 2—Clear cell adenocarcinoma arisen from endometriotic cyst of left ovary (International Federation of Gynecology and Obstetrics stage Ic) in 35-year-old woman.
A–C, There are two cysts in pelvis: Larger cyst shows high signal on T2-weighted image (**A**) (TR/TE_{eff}, 1,800/100) and slightly high signal on T1-weighted image (**B**) (TR/TE, 594/10). Signal was not suppressed by fat-suppressed T1-weighted image (**C**) (680/10). There are two papillary projections (*arrows*) on floor of cyst that show high signal on T2-weighted image and low signal on T1-weighted image. We can also see another cyst (*arrowheads*) that is diagnosed as typical endometriotic cyst in contralateral ovary. It shows high signal intensity on T1-weighted images and diffusely low signal intensity on T2-weighted image. Note lack of shading on T2-weighted image in endometriotic cyst with malignancy.
D, After administration of gadolinium-based contrast medium, enhanced fat-saturated T1-weighted image (680/10) shows that center parts of nodules were strongly enhanced.
E, Photomicrograph of histologic specimen shows that tumor is composed of tumor cells deranged in papillary fashion, accompanied by ectopic endometrial glands with stroma. (H and E, low-power field)

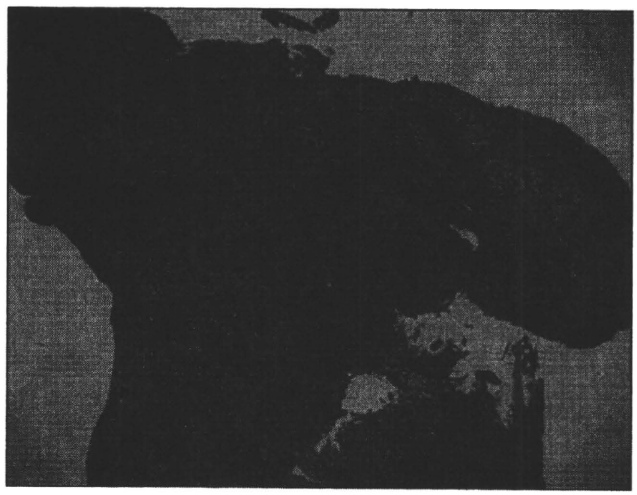
rous in two cases, mucinous in one case, and endometrioid in one case for the borderline malignancies, whereas the histologic subtype was serous in five, clear cell in eight, endometrioid in 11, and mixed in three for adenocarcinomas. Postoperative clinical stage, established using the International Federation of Gynecology and Obstetrics classification system of 29 malignant ovarian tumors, was Ia in eight, Ib in two, Ic in six, IIc in three, IIIa in one, and IIIc in nine.

The imaging characteristics of the study group are summarized in Table 2.

The mean age of the patients with a benign condition was 36 years (range, 25–57 years), whereas that of patients with a malignant condition was 44 years (range, 26–65 years) (Fig. 4). The mean age was significantly higher in the malignant group than in the benign group ($p < 0.05$, Mann-Whitney U test). The mean maximum cyst diameter was 7.8 cm (range, 3.2–14.2 cm) in the benign group and 11.2 cm (range, 4.0–19.2 cm) in the malignant group (Fig. 5). It was also significantly larger in the malignant group ($p < 0.05$, Mann-Whitney U test). Disease was unilateral in seven of the 16 benign cases and 12 of the 33 malignant



A B C



D

Fig. 3—Endometriotic cysts of bilateral ovaries in 35-year-old woman. There are two multilocular cystic masses in pelvic cavity. One is located at right posterolateral side of uterus and other, at left anterolateral side.
A–C, Both cysts show high signal intensity with hypointense capsule and septa on T1-weighted image (**A**) (TR/TE, 594/10). Left anterior mass (*arrows*) has papillary projection on wall of cyst with low signal intensity on both T1-weighted image and T2-weighted image (**B**) (TR/TE_{eff}, 1,800/100) and shows contrast enhancement on enhanced fat-saturated T1-weighted image (**C**) (680/10). Content of cyst with papillary projection shows low signal intensity on T2-weighted image in contrast to Figure 2B due to shading.
D, Photomicrograph shows that papillary projection is composed of fibrotic tissue with hemorrhage within endometriosis. On the other hand, right posterior mass that partly included hyperintense fluid on T1-weighted images that showed shading on T2-weighted images can be also diagnosed as endometriotic cyst. It does not show any protrusion of cyst wall. (H and E, low-power field)

cases. The ratio of the maximum diameter of the affected cysts to the maximum diameter of the contralateral cysts was larger in the malignant group (range, 0.6–296.3; mean, 29.6) than in the benign group (range, 0.5–5.7; mean, 2.2); however, the difference was not statistically significant.

Thirteen of the 16 benign cysts showed shading on T2-weighted images, whereas shading was seen in only 11 of the 33 malignant cysts. The shape of the cyst wall protrusion was nodular in 11, papillary in three, multilocular cystic in 0, and localized wall thickening in two in the benign group and was 17, 14, two, and 0 in the malignant group, respectively. Nodular- and papillary-shaped mural nodules were seen in both groups; however, localized wall thickening was seen in only the benign group. The mean maximum diameter of the mural nodules was 1.2 cm (range, 0.4–2.3 cm) in benign and 4.3 cm (range, 1.0–8.7 cm) in malignant lesions. It was also statistically larger in the malignant group ($p <$ 0.0001, Mann-Whitney *U* test) (Fig. 6).

The signal intensity of the mural nodules varied in both groups on T1- and T2-weighted images. On T1-weighted images, the malignant mural nodules showed high signal in two patients, intermediate signal in seven, and low signal in 24, whereas the benign mural nodules showed signal in three, four, and 9, respectively. On the other hand, on T2-weighted images, the malignant mural nodules showed high signal in 18 patients, intermediate signal in nine, and low signal in six, whereas the benign mural nodules showed signal in nine, two, and five, respectively. All but one malignant lesion had enhancing mural nodules, but there were seven benign masses with enhancing mural nodules (Figs. 2 and 3).

Discussion

Endometriosis is defined as the presence of endometrial tissue outside the endometrium and myometrium. This condition is predominantly found in women of reproductive age and typically causes pelvic pain and infertility. Ovaries are one of the most common sites that endometriosis affects. One of the major treatment options is surgical removal of the ovaries; however, preservation of the reproductive function is desirable in most women with endometriosis [17]. Development of hormonal therapy, such as gonadotropin-releasing hormone agonist and the tendency to put off marriage in developed countries have caused the rate of hysterectomy from endometriosis to decrease [18]. This phenomenon results in an increased number of patients with endometriosis seeking care in outpatient clinics. On the other hand, malignant tumors that develop from endometriotic cysts have come to the attention of gynecologists [1, 2, 19]. Although the exact prevalence of malignant tumors arising from endometriotic cysts of the ovary is unknown, studies in Japan have indicated a prevalence of approximately 0.7% [20, 21]. Investigators have also reported that clear cell and endometrioid adenocarcinomas are the malignancies most commonly seen in ovarian endometriosis [22, 23].

In our series, 11 of the 33 malignant tumors were endometrioid adenocarcinoma, which was the leading pathology, and eight were clear cell adenocarcinoma. These findings with regard to prevalence are similar to those in previous reports. The results of a clinicopathologic study also indicated that ovarian cancer

TABLE 2: Patient Age and Imaging Characteristics of the Cases

Characteristic	Pathologic Diagnosis		*p*
	Benign	Malignant	
Patient age (y)			< 0.05
Mean	36	44	
Maximum cyst diameter (cm)			< 0.05
Mean	7.8	11.2	
Unilateral vs bilateral, no. of cases			—
Unilateral	7	12	
Bilateral	9	21	
Ratio of maximum diameter of affected cyst to maximum diameter of contralateral cyst			NS
Mean	2.2	29.6	
Shading present, no. (%) of patients	13/16 (81.3)	11/33 (33.3)	—
Shape of mural nodules, no. of cases			—
Nodular	11	17	
Papillary	3	14	
Multilocular cystic	0	2	
Localized wall thickening	2	0	
Maximum diameter of mural nodules (cm)			< 0.0001
Mean	1.2	4.3	
Signal intensity of mural nodules			
T1-weighted imaging			—
High	3	2	
Intermediate	4	7	
Low	9	24	
T2-weighted imaging			—
High	9	18	
Intermediate	2	9	
Low	5	6	
Enhancement of mural nodules present, no. (%) of cases	7/16 (43.8)	32/33 (97.0)	—

Note—Dash (—) indicates not applicable. NS = not statistically significant.

with endometriotic cysts tended to show at an earlier stage and to be associated with a better prognosis than conventional ovarian cancer without endometriosis [3, 24]. Tanaka et al. [6, 12] reported enhancing mural nodules were the most important risk factor for ovarian cancer arising from endometriosis; however, other pathologic conditions with such imaging findings have also been reported [8, 9, 11–14] including polypoid endometriosis [14], decidualized endometriotic cysts during pregnancy [11, 12], Müllerian mucinous borderline tumors [13], and so on. Therefore, other imaging criteria are needed to detect coexisting malignancy.

Kobayashi et al. [4, 21] reported that postmenopausal women had a high risk of ovarian cancer arising from endometriosis during a follow-up period of up to 17 years in a cohort of patients with ovarian endometriomas. Our study also indicated that patients with malignancy were significantly older than those without malignancy. In the era of MRI, radiologists can easily diagnose ovarian endometriotic cysts with multilocular cystic masses [25], adhesions [26], hyperintense fluid on T1-weighted images, and shading on T2-weighted images [15, 25]. Therefore, we should pay attention to the possibility of coexisting malignancy when diagnosing endometriotic cysts of the ovaries especially in patients older than 45 years.

Kobayashi et al. [21] reported that there is an increased risk of malignancy in endometriotic cysts larger than 10 cm. Our study showed the mean diameter of the cysts with malignancy was 11.2 cm, which was significantly larger than that of cysts without malignancy. On the other hand, Tanaka et al. [6] reported that endometriotic cysts with malignancy tended to show unilateral disease or were larger compared with contralateral disease. In this study, 44% of patients with benign findings showed unilateral disease, whereas only 36% of patients with malignant conditions had unilateral disease. Therefore, larger cyst size seems to be a risk factor for malignancy, although asymmetric cyst size did not show a statistically significant correlation with coexisting malignancy.

Lack of shading on T2-weighted images has been reported as another risk factor for malignancy [6]. In this study, 81% of benign cysts showed shading on T2-weighted images, whereas shading was seen in only 33% of the malignant cysts. Because epithelial ovarian carcinomas typically appear as predominantly cystic mixed masses [16], the tumor cells are expected to produce some fluid. On the other hand, hemorrhagic fluid is within the endometriotic cysts before carcinoma develops, which causes shading that appears as prominent low intensity within a loculus on T2-weighted images [15]. Therefore, dilution of the hemorrhagic contents by nonhemorrhagic fluid produced by the malignant tumors may be a cause of lack of shading.

Mural nodules with contrast enhancement seem to be the most valuable imaging finding suggestive of coexisting carcinoma [6, 7]; however, other conditions with this finding have also been reported [8–13]. Polypoid endometriosis is an uncommon and distinctive form of endometriosis with histologic features simulating an endometrial polyp. It has been defined as "exophytic or polypoid, tumor-like masses that project from a serosal or mucosal surface or from the lining of an endometriotic cyst" [27]. This entity, associated with tamoxifen therapy against breast cancer, has also been reported in the pathology literature [27, 28]. Kraft and Hughes [9] and Takeuchi et al. [14] independently reported one patient with polypoid endometriosis that showed mural nodules on the endometriotic cysts of the ovary. This entity and nodular endometriosis reported by Onbas et al. [10] showed intense enhancement with gadolinium-based contrast materials. In fact, seven of 16 cases without malignancy in our study also showed mural nodules with contrast enhancement. In these cases, one had granulomatous tissue within the ectopic endometriotic tis-

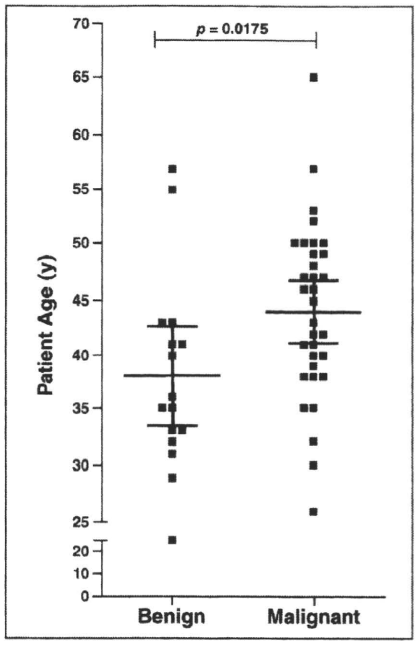


Fig. 4—Statistical analysis using Mann-Whitney *U* test reveals that age of patients in malignant group is significantly higher than benign group ($p < 0.05$). Long horizontal bar indicates mean and short bars, ± 1 SD.

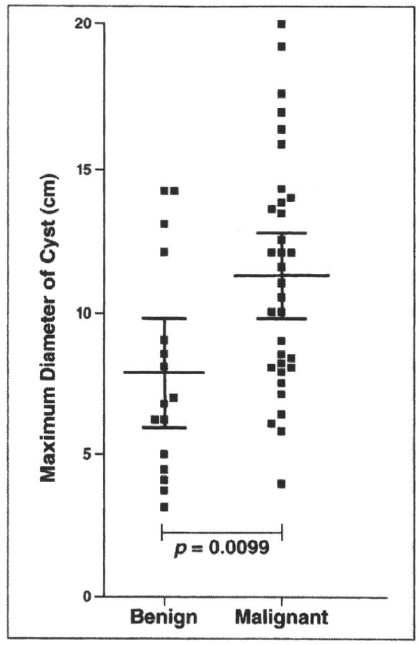


Fig. 5—Statistical analysis using Mann-Whitney *U* test reveals maximum diameters of cysts in malignant group are significantly higher than those in benign group ($p < 0.0099$). Long horizontal bar indicates mean and short bars, ± 1 SD.

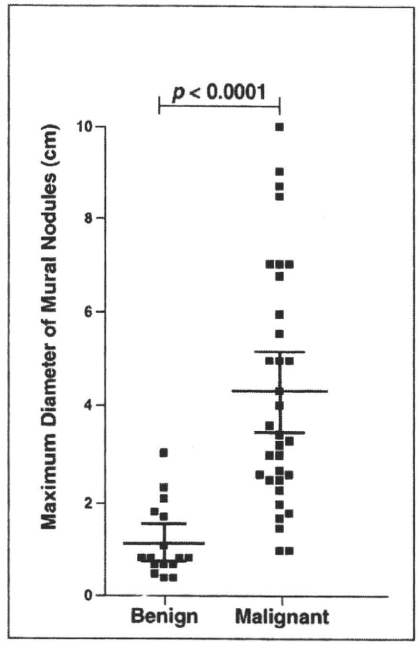


Fig. 6—Statistical analysis using Mann-Whitney *U* test reveals maximum diameters of mural nodules in malignant group are significantly higher than those in benign group ($p < 0.0001$). Long horizontal bar indicates mean and short bars, ± 1 SD.

sue; however, most of the cases were composed of only endometriosis. Thus, even benign endometriotic tissue can produce a mural nodule with contrast enhancement.

Deciduosis of the ectopic endometrial tissue is another cause of mural nodules on the endometriotic cysts [11, 12]. Decidualized endometriotic cysts usually show extremely high intensity on T2-weighted images and are isointense to the placenta on all MR sequences [12]. Therefore, we believe that they may be distinguished from malignancy by clinical findings and the signal intensity of the mural nodules. Kataoka et al. [13] reported cases of Müllerian mucinous borderline tumor arising from endometriotic cysts. In their study, the tumors appeared as mural nodules on the endometriotic cysts, which showed prominent high signal intensity on T2-weighted images [13]. One of the patients in our study also had a Müllerian mucinous borderline tumor in which the mural nodules showed very high signal intensity on T2-weighted images. On the other hand, 17 other malignant and nine benign cases in our study showed hyperintense mural nodules on T2-weighted images. Outwater et al. [29] reported that large papillary projections corresponding to neoplasms had distinct internal architecture including a fibrous stalk supporting clumps of edematous papillae. They also mentioned that even a functional ovarian cyst could make nondescript papillary projections that show intermediate signal on T2-weighted images. Because we studied only the signal intensity of the mural nodules but not the internal architecture, we cannot comment about this issue. The results of our study did indicate that the signal intensity on T2-weighted images varied in both benign and malignant groups. In addition, even papillary projections as small as 1 cm in diameter were within malignant tumors. Therefore, we speculate that we cannot accurately diagnose the pathology of mural nodules by their signal intensity.

The size of mural nodules has not been evaluated in any other study, to our knowledge, concerning neoplasms accompanied by endometriotic cysts. Our study revealed that the maximum diameter of the mural nodules was significantly larger than that of benign conditions. We speculate that this characteristic may be the third point to distinguish malignancy arising from endometriosis from benignancy. However, there was some overlap between the malignant and benign groups. The smallest mural nodule of the malignant group was 1.0 cm, whereas the largest mural nodule of the benign group was 3.0 cm. Therefore, the findings are indeterminate for mural nodules with a diameter of between 1.0 and 3.0 cm.

The differential diagnosis of endometriosis is important because we had to remove six cysts that met our MR criteria but did not have endometriosis by pathologic examination. We believe that the adhesive findings may be a hallmark of endometriosis; however, our criteria did not include imaging findings suggesting adhesion such as posterior cul-de-sac obliteration, retroversion of the uterus, or elevation of the posterior vaginal fornix [30]. Therefore, six cases without endometriosis met our MR criteria for endometriotic cysts. In these cases, three of the six were primary epithelial ovarian carcinoma, two were epithelial ovarian tumor of borderline malignancy, and the remaining one was a metastatic tumor of the endometrial carcinoma. Radiologists should know that malignant ovarian tumors—even borderline malignancies—may have bleeding and may mimic endometriotic cysts.

There are some limitations in this study. First, there was selection bias in the study population. We selected cases with endometriosis using findings of unenhanced MRI. As others have previously reported, endometriosis in mild disease cannot be diagnosed even with fat-saturated T1-weighted images [26, 31]. Therefore, endometriosis with mild disease or atypical MR findings might have been excluded from this study. On the other hand, nine of

33 cases with malignancy had stage IIIc disease. Some of these were apparently malignant by ancillary criteria including intraperitoneal dissemination or lymph node metastases [16]. Thus, an advanced stage of disease might cause significant differences between malignancy and benignancy. If the study population is limited to those with stage I disease, then further evaluation will be needed.

In this study, our cases did not always match the criteria for ovarian carcinoma arising from endometriosis advocated by Sampson [1]. According to those criteria, the ovarian carcinomas should include the transitional pathology between the benign endometrial tissue with their stroma and the malignant tumors. However, we did not see such transitional lesions histopathologically in our cases. Therefore, our cases may include cases with endometriotic cysts incidentally seen with other pathology, as reflected in the title of our article.

The third limitation is that the MR protocols used were not uniform, with different parameters such as slice thickness or number of excitations, because of the retrospective nature of this study. In this study, we emphasized the size of the mural nodules, some of which were less than 1 cm. Because strict calculation is needed in this kind of study, a 10-mm slice thickness seemed inadequate.

The results of our study revealed that malignant tumors associated with endometriotic cysts tended to appear in older patients, in patients with larger endometriotic cysts, and in patients with endometriotic cysts without shading on MRI, as previously reported. Enhanced mural nodules are still an important finding, but there are some exceptions. We emphasize the importance of the size of the mural nodules in diagnosing malignancy associated with endometriotic cysts. Despite some overlap, the presence of mural nodules larger than 3 cm in maximum diameter was a strong indicator of coexisting malignancy in our study.

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