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Borderline ovarian tumors: Importance of morphologic features, and contribution of MRI to diagnosis

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Abstract

Aim: Differential diagnosis of borderline ovarian tumors (BOT) and malignant lesions with MRI is of great importance in terms of recognizing the chance of fertility preserving surgery. We aimed to describe and compare the MRI imaging findings and morphologic features of borderline and malignant ovarian tumors.

Materials and Methods: Patients who underwent pelvic MRI due to adnexal mass between 2019 and 2024 in the Radiology departments of two centers have been screened. Thirty-six lesions from 34 patients with BOT were identified and compared with the randomly selected 20 malignant adnexal tumors in 19 patients. Morphological features of lesions, contrast enhancement pattern, Apparent Diffusion Coefficients values, presence of ascites and peritoneal implants were evaluated for each lesion.

Results: Type 3 contrast enhancement pattern was reported in 8% of BOTs, and 26% of the malignant tumors. No significant difference was observed between BOT and malignant lesions in terms of contrast enhancement pattern ($p = 0.274$). In patients with BOTs, our rate of differentiating the ipsilateral ovary was higher than in malignant patients. Ipsilateral ovary was not discriminated in 25 (69.4%) of the BOTs, and 18 (90%) of the malignant lesions, with a borderline statistical significance ($p = 0.075$). Although the papillary lesions were commonly borderline and big-amorph lesions were commonly malignant, the difference did not reach statistical significance ($p = 0.078$).

Conclusion: Presence of solid tissue and the type of solid component are the most prominent features for the distinction of BOTs and malignant lesions. Time-intensity curves may provide additional information.

Introduction

Borderline ovarian tumors (BOTs) are subgroup of epithelial ovarian tumors. They constitute approximately 15% of primary ovarian neoplasms [1, 2]. They have a better prognosis than malignant epithelial tumors and occur approximately 10 years earlier. They are usually seen between 40-50 years of age [3, 4]. Approximately 1/3 of the patients are under the age of 40 years [5, 6]. Since this patient group is in the reproductive period, it is important to have the chance of fertility preserving surgery.

Seventy-five percent of borderline tumors are at stage 1 at the time of diagnosis, and the 5-year survival rate is 95-97% [2]. Serous and mucinous borderline tumors constitute the majority of histologic subgroups. Less frequently seromucinous, endometrioid, clear cell, and Brenner tumors are encountered [7, 8].

Imaging modalities are of great importance in diagnosis. Ultrasound (US) is the first-line imaging modality. Computed Tomography (CT) contributes to staging and detection of regional lymph nodes and distant metastases in addition to the recognition of the lesion. Magnetic Resonance Imaging (MRI) provides more detailed information about the origin of the lesion, the presence of a solid component, and the type and signal characteristics of the solid component. The definitive diagnosis is made histopathologically but the diagnosis on the MRI report may be decisive for the selection of the appropriate treatment protocol, especially at young ages.

Differential diagnosis of BOT and malignant lesions with MRI is of great importance in terms of recognizing the chance of fertility preserving surgery, especially in young patients. In this study, we aimed to describe and compare the MRI imaging findings and morphologic features of borderline and malignant ovarian tumors.

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Materials and Methods

Population

Patients who underwent pelvic MRI due to adnexal mass between 2019 and 2024 in the Radiology departments of the Bilkent City Hospital, Ankara, and Başakşehir Çam and Sakura City Hospital, Istanbul, have been screened on the hospital databases. The images were evaluated by two radiologists with 15 and 8 years of experience in abdominal radiology.

This study was approved by the Ethics committee of the Bilkent City Hospital (12.06.2024; TABED 2-24-249). As the data were obtained from the images recorded in the hospital database informed consent was waived.

Thirty-six lesions from 34 patients with borderline tumors were identified and compared with the randomly selected control group of 20 malignant adnexal tumors in 19 patients. Size, number of septa, presence of solid component, type of solid component, contrast enhancement pattern, Apparent Diffusion Coefficients (ADC) values, presence of ascites and peritoneal implants were evaluated for each lesion. The number of the septa was categorized as less than 3, between 3-5 and more than 5 similar to previous studies. The ipsilateral ovary was assessed for differentiation from the lesion.

MRI examinations

MRI examinations were performed with 3T MRI scanners. The sequences and other acquisitions parameters used for imaging are shown in Table 1. MRI examinations that were performed without intravenous contrast material administration were excluded. Contrast enhancement was assessed visually and compared with the contrast enhancement of the outer myometrium at 30-40 s. and was evaluated as Type 1, 2 and 3.

Statistical analysis

Continuous variables were presented as median and interquartile range (IQR), and compared using Mann-Whitney-U test. Categorical variables were presented as frequency and percentages, and compared using chi-squared test or Fisher's exact test where appropriate. A p-value of <0.05 was considered statistically significant. Analyses were conducted using Stata v17 (StataCorp, TX, USA).

Results

The study group included 36 BOTs from 34 patients and 20 malignant lesions from 19 patients. There was no significant difference in age between patients with borderline lesions and malignant lesion (median [IQR] age 42 [35 – 55] vs. 46.5 [40.5 – 61.5] years; p = 0.427).

No significant difference was observed between BOT and malignant lesions in terms of contrast enhancement pattern (p = 0.274; Figure 1).

Ipsilateral ovary was not discriminated in 25 (69.4%) of the BOTs, and 18 (90%) of the malignant lesions, with a borderline statistical significance (p = 0.075).

Borderline tumors

The lesions frequently contained septa and solid components. Sixteen (44%) lesions had more than 5 septa, 16 (44%) lesions had less than 3 septa, and 1 (2.7%) lesion had between 3-5 septa. Solid components were present in 23 (64%) lesions.

Eleven of the lesions (30%) contained papillary projections, 2 (5.5%) contained papillary projections and branching papillae, 1 (2.7%) contained branching papillae, 2 (5.5%) contained mural nodules, and 7 (19%) contained large amorphous solid components. Of the tumors containing papillary projections, 1 was endometrioid and 1 was mucinous borderline tumor, and the remaining were serous or seromucinous tumors. The lesions containing large solid components were endometrioid and mucinous BOT.

All patients had variable amounts of pelvic fluid.

In terms of contrast enhancement pattern, 15 lesions (42%) had type 1, 6 (16%) lesions had type 2 and 3 lesions (8%) had type 3 contrast enhancement pattern. No significant difference was observed between BOT and malignant lesions in terms of contrast enhancement pattern (p = 0.274; Figure 1).

The ipsilateral ovary could be differentiated in 30% of the lesions.

Table 1. MR acquisition parameters.

Sequence	Plane	TR	TE	Slice thickness	FOV
T2	Coronal	5869	115	5.5	34x34
T2	Axial	3456	112	5.5	34x34
T2	Sagittal	4396	114	5.5	30x30
T1	Axial	812	10	5.5	34x34
T1+C	Coronal	691	8.9	5.5	34x34
T1+C	Sagittal	820	8.9	5.5	30x30
T1+C Lava	Axial	5.4	1.8	4	38x26.6

FOV, field of view; TE, time to echo; TR, time to repetition.

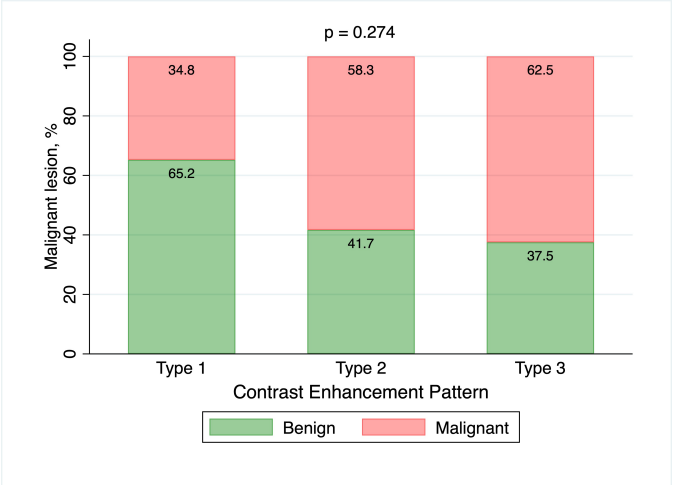

Figure 1. Contrast Enhancement Pattern of Borderline and Malignant Tumors.

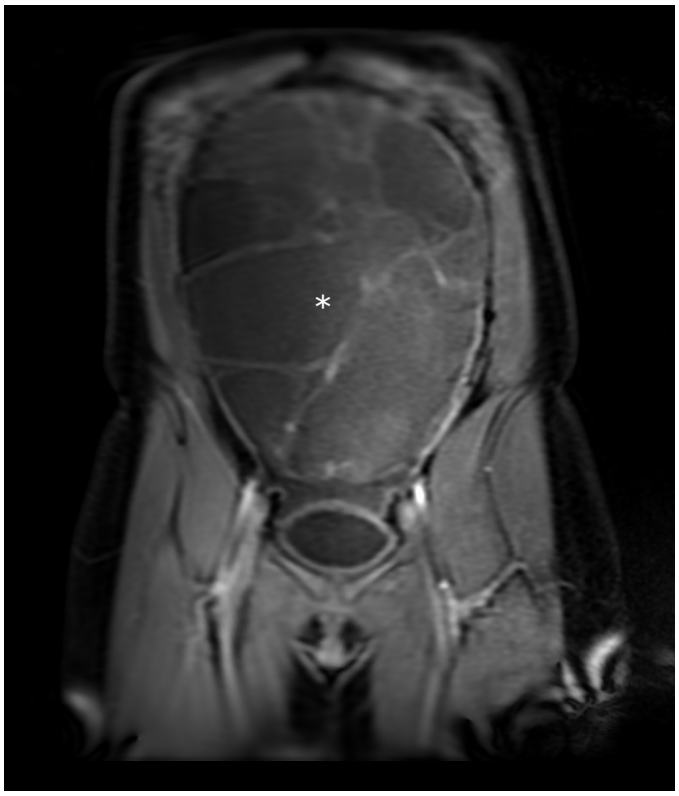

Figure 2. Coronal fat-suppressed contrast enhanced T1 image of mucinous malignant tumor with more than 5 septa.

Malignant tumors

Five of the malignant lesions had more than 5 septa (Figure 2), 3 had between 3-5 septa and 9 had less than 3 septa. Nineteen of the 20 lesions had a solid component. The only lesion without solid component was mucinous carcinoma with septa. Twelve (60%) of the lesions were large amorphous (Figure 3A, 3B, 3C), 1 had branching papilla (5%), 3 had papillary projection (15%) (Figure 4), 2 had solid mural nodules (10%) and 1 had papillary projection and branching papilla (5%).

Of the malignant lesions, 8 (40%) had type 1, 7 (35%) had type 2, and 5 (25%) had type 3 contrast enhancement patterns. Although the papillary lesions were commonly borderline, and big-amorph lesions were commonly malignant, the difference did not reach statistical significance (p=0.078; Figure 5).

The ipsilateral ovary could be differentiated in only one patient.

Ca-125 levels were lower in BOTs than in malignant lesions (median and IQR values 50 [16 – 106] vs. 133 [26 – 826]), but did not reach the statistical significance level (p=0.108). There was no significant difference between borderline and malignant tumors with regard to the O-RADS score (p = 0.198). Notably, 83.3% of the borderline tumors and 86.7% of the malignant tumors were either O-RADS 4 or 5.

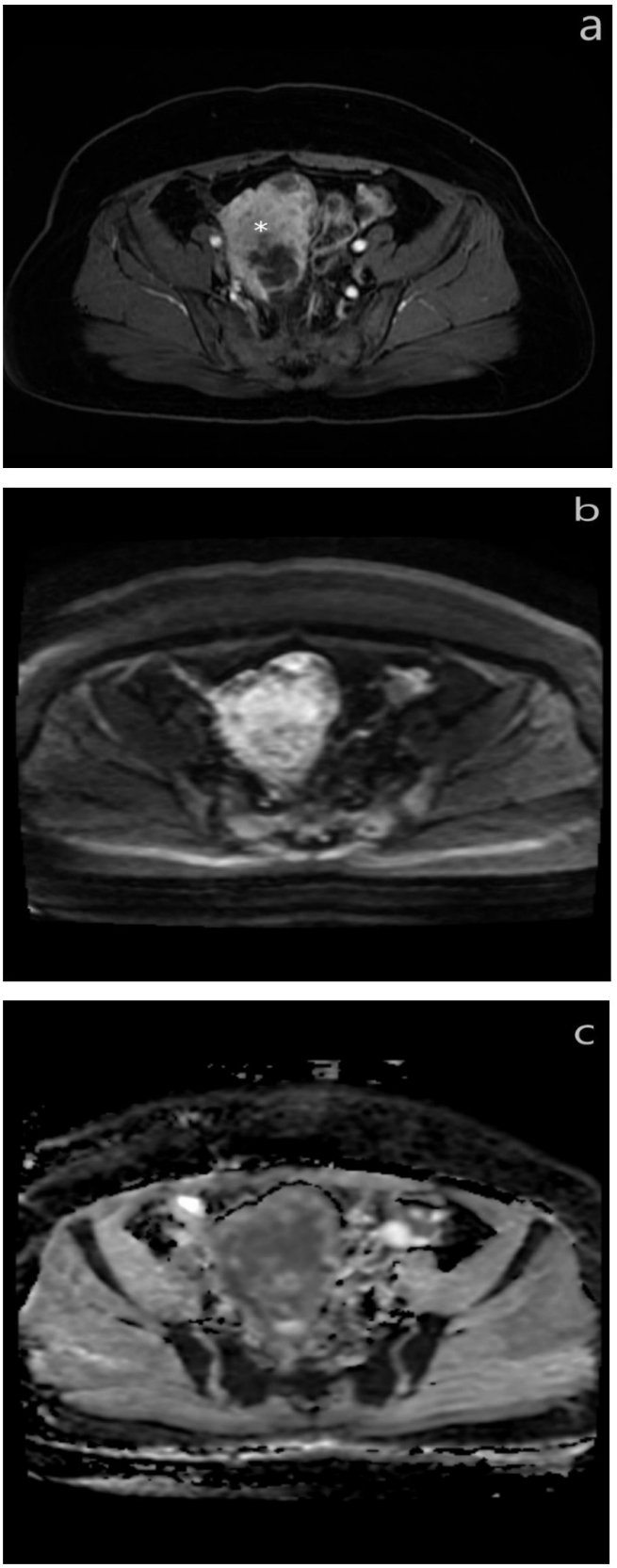

Figure 3. A: Axial fat-suppressed contrast enhanced T1 image of endometrioid malignant tumor with amorphous solid component, B: Axial diffusion weighted imaging of endometrioid malignant tumor with amorphous solid component, C: Apparent diffusion coefficient (ADC) imaging of endometrioid malignant tumor with amorphous solid component.

Discussion

Ovarian epithelial tumors are categorized as benign, borderline and malignant. In the 2020 World Health Organization (WHO) classification, BOTs are defined as a separate entity [9, 10, 11]. Borderline tumors constitute 15-20% of ovarian epithelial tumors [12].

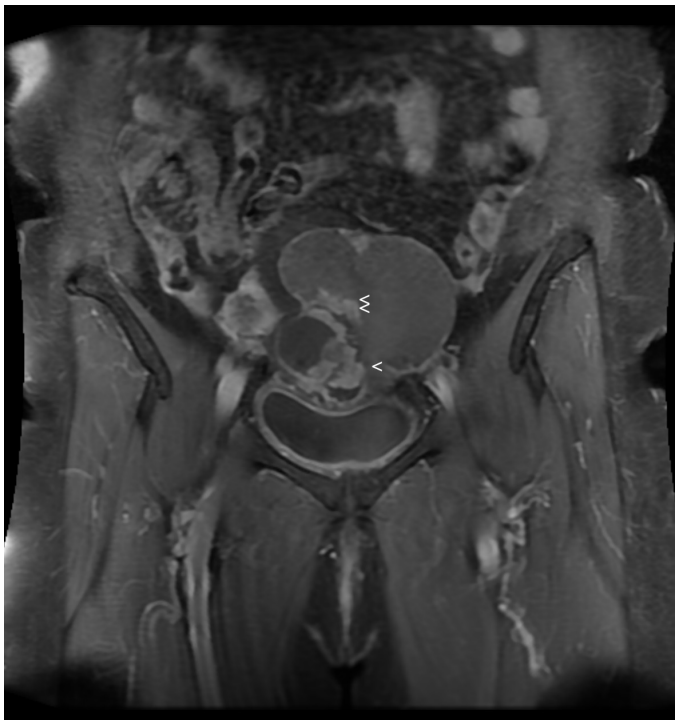

Figure 4. Coronal fat-suppressed contrast enhanced T1 image of serous malignant tumor with papillary projections (arrowheads).

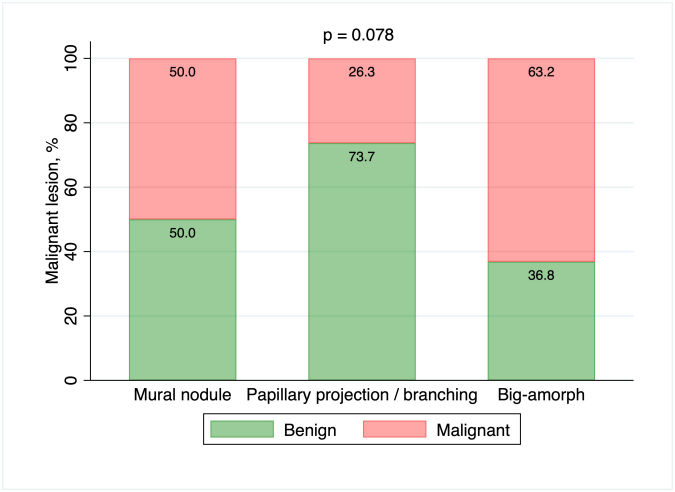

Figure 5. Type of solid components of Borderline and Malignant Tumors.

Borderline ovarian tumors may be detected incidentally or patients may present with nonspecific symptoms. Accurate recognition of these tumors is important to give the patient the chance for fertility-sparing surgery such as cystectomy or unilateral oophorectomy. MRI allows detailed evaluation of indeterminate adnexal masses due to its high soft tissue resolution and multiplanar imaging capacity. It allows differentiation of fat, hemorrhage, solid components and understanding of the fluid content of the lesion (fat, endometioid, proteinaceous).

Borderline ovarian tumors may be purely cystic or may contain septa, mural solid nodules and large solid components. Only one BOT was purely cystic in our study. They usually have fewer septa and solid components than malignant tumors. Malignant tumors may contain a large number of contrast enhancing septa or large solid components, their contours may be irregular and poorly circumscribed [13]. In our study, approximately 65% of BOTs had solid components whereas 89% of malignant lesions had solid components.

Papillary lesions were commonly borderline, and big-amorph lesions were commonly malignant. The borderline statistical significance might be due to low sample size.

Histological subtypes

Serous Borderline tumors are the most common type of borderline tumors. In our study, 37% of the lesions were serous BOT. Thomassin-Naggara et al. reported that papillary projections were more common in serous BOT and large solid tissue was more common in malignant tumors [14].

There are studies reporting that papillary projections and branching papillae support serous BOT [15]. Similarly, we detected papillary projections and branching papilla structures more frequently in serous and ceromusinous tumors. Of the 14 lesions with papillary projections and branching papillae, 12 were serous or ceromusinous tumors.

While it was previously considered that BOTs did not cause stromal invasion, later reports suggest that serous BOTs may cause microinvasions at a depth of less than 5 mm [16]. In our study, no peritoneal implant was seen on pelvic MRI in any of the borderline and malignant lesions. It is difficult to determine the presence of a peritoneal implant with MRI and upper abdominal slices need to be evaluated. Abdominal tomography is a more effective modality to search for implants.

It has been reported that ovarian stroma is preserved in 58% of cases in serous BOT [17]. Differentiation of the ovary on the side of the lesion may also support BOT. However, radiologic visualization of the ovary on the lesion side is also related to the size of the lesion. The relatively low rate of ipsilateral ovarian visualization in BOTs (1/3) in this study was considered to be related to lesion size. The mean size of a total of 25 lesions in which the ipsilateral ovary could not be differentiated was 136 mm.

Mucinous BOTs constitute approximately 1/3 of borderline ovarian tumors [18]. Consistent with the literature, the rate of mucinous BOTs was found to be 32% in this study. They are usually seen as multiloculated cystic masses. In mucinous borderline tumors, papillary projections are found less and irregular septations are found more [19, 20]. While hypointense microcysts on T2-weighted images and reticular contrast on MRI support mucinous BOT, solid component and mural nodules are more common in malignant tumors [21]. Nine of the 12 mucinous BOTs in our study did not have a solid component and all of them were multiseptated. In our study, 7 of the borderline BOTs were of the ceromucinous type. Only 1 lesion had a large solid component, and others contained papillary projections or branching papillae.

It has been reported in the literature that endometrioid BOTs constitute 2-3% of the borderline tumors [8, 9]. In our case, it constituted 8% of all BOTs.

Borderline Brenner tumors are also extremely rare [9]. It is difficult to differentiate malignant from borderline benign tumors according to imaging features [22]. In our series,

two patients with Brenner tumors were histopathologically benign and were excluded from the study as we did not include benign lesions.

Clear cells BOTs constitute less than 1% of BOTs [9]. There were no clear cells BOTs in our study.

MRI characteristics

Morphologic features are important in predicting histologic subtype of ovarian tumors. It is not possible to make a definitive diagnosis with MRI alone, intraoperative frozen section and histopathologic sampling are necessary, especially in making the decision for fertility-sparing surgery [23]. However, in mucinous BOTs, there is a possibility of misdiagnosis because of the large lesion size and heterogeneous structure [24, 25]. In such lesions, preoperative imaging has a high diagnostic contribution and may strengthen the histologic diagnosis.

Diffusion-weighted imaging and ADC values may give an idea about whether the lesion is benign, borderline or malignant. It has been shown that diffusion restriction is less and ADC values are higher in borderline lesions compared to malignant tumors. However, due to differences in technical parameters, it is difficult to determine a cut-off value that can be used in differential diagnosis in ADC [26, 27]. Since our study was conducted at two centers with MR images from three different MR devices, no comparison could be made in terms of ADC values.

The contrast enhancement pattern depends on the amount of fibrous or vascular component of the tumor. In dynamic contrast-enhanced MR, Type 2 time intensity curve (TIC) is more common in Borderline tumors and Type 3 TIC is more common in malignant tumors [14, 28]. In our study, Type 3 contrast enhancement pattern was reported in 8% of BOTs and 26% of the malignant tumors. Type 1 contrast enhancement in malignant lesions was higher in our study. This may be due to the fact that visual assessment was performed and dynamic contrast curves were not plotted and the total number of malignant lesions was low. Dynamic MRI examination may increase the accuracy in these lesions. In addition, if the size of the solid component is small, there is a possibility of misclassification in terms of the amount of contrast enhancement [29]. In our study, no significant difference was observed between BOT and malignant lesions in terms of contrast enhancement pattern ($p = 0.274$).

Ascites and peritoneal implants can also be seen in borderline tumors and do not confirm the diagnosis of malignancy. Especially in serous borderline tumors, ascites may be present in large amounts and is not a reliable finding in differentiation from malignant tumors [15, 30]. Peritoneal implants have been reported to be seen in 41% of malignant tumors and 10% of borderline tumors [13]. However, peritoneal implants are difficult to detect with MR. In our study, no peritoneal implant was detected in any of the patients on pelvic MRI.

While it is more difficult to see the same side ovary in malignant tumors, it is more possible to see the same side ovary in BOTs because of less stromal invasion and tissue destruction. In patients with BOTs, our rate of differentiating the ipsilateral ovary was higher than in malignant patients. However, due to the large lesion size, ipsilateral ovary could not be differentiated in 25 /36 of the BOTs. In only one of the malignant lesions, ipsilateral ovary could be detected.

Increased tumor markers are seen in 25-60% of BOTs [31, 32] and have been reported especially in advanced tumors. In early stage tumors, the level of serum tumor markers may not be instructive. The normal level does not exclude the diagnosis of BOT [33]. There are variable values according to the stage of the disease and histologic subtype. This increases the importance of preoperative MRI examination. In the present study, while the Ca-125 levels were higher in malignant lesions compared with the BOTs, it does not reach the statistical significance level.

The low sample size is the major limitation of this study. With a conventional alpha level of 0.05, degrees of freedom of 2, and Cohen's effect size of 0.5, the power of the study is calculated to be 77%, which falls slightly below the conventional threshold of 80%. Therefore, the study's findings should be interpreted with this limitation in mind. This study provides preliminary data to inform the design of a future multicenter trial with a larger sample size, which is currently in the planning stage.

Conclusion

Since BOTs are seen at younger ages, fertility preserving surgery is important in this group. The presence of ascites and Ca-levels are not reliable in differentiating borderline from malignant. Peritoneal implants may be difficult to detect with MRI. In our study, the presence of solid tissue and the type of solid component were found to be the most reliable parameters evaluated for BOT-malignant differentiation in accordance with the literature. Drawing a TIC curve may be more reliable in the evaluation of contrast enhancement. Our study is important to emphasize what radiologists should pay attention to when evaluating lesions in MR reporting.

Ethical approval

This study was approved by the Ethics committee of the Bilkent City Hospital (12.06.2024; TABED 2-24-249).

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