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EFFECT OF MAGNETIC RESONANCE IMAGING IN THE DIAGNOSIS OF OVARIAN CANCER

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Abstract:

Due to the high contrast resolution, MRI is used to solve problems for sonographically indeterminate ovarian formations. To differentiate solid formations of appendages, high-quality diffusion-weighted MRI imaging is widely used, so that intravenous administration of a contrast agent can be avoided, which makes this technique indispensable in the presence of contraindications to contrast and during pregnancy.

Keywords: MRI, ovarian cancer, DVI, dermoid, ESUR.

OVARIAN CANCER: GENERAL ASPECTS

Malignant tumors of the reproductive system: breast cancer and gynecological tumors (cancer of the body, cervix and ovaries) are the most common in the structure of oncological morbidity in women, and their total proportion exceeds 35%. According to some reports, ovarian cancer accounts for 3–6% of malignant tumors in women and ranks seventh in frequency. The lifetime risk of developing ovarian cancer in women is approximately 1:70, and it is estimated that there are about 21,550 new cases of the disease each year in the United States, and 14,600 deaths among them. Countries in Africa, Asia and Southern Europe have the lowest cancer incidence rates. In Uzbekistan, the incidence of ovarian cancer is 4.9 per 100,000 female population. Most ovarian cancer occurs in peri- and postmenopausal age. Approximately 20% of ovarian cancers occur before the age of 40. This is especially true for rare non-epithelial types of cancer. Despite a significant improvement in 5-year survival over the past three decades, ovarian cancer still carries a poor overall prognosis. The 5-year survival rate is reported to be 50–90% for early disease (stages 1 and 2) and 21% for advanced disease (stages 3 and 4).

Primary ovarian neoplasms include neoplasms of epithelial, germinal, and stromal origin. The most common type is epithelial ovarian cancer (85–90%), which is classified by cellular origin into serous (60%), mucinous (5%), clear cell (10%), endometrioid (10–20%), Brenner tumor, and undifferentiated cancer (1%). In addition, based on histopathological features and clinical presentation, epithelial tumors are classified into benign, malignant, and borderline tumors.

Ovarian cancer has a wide range of pathological features. They can range from solid to solid cystic, predominantly cystic, often with serous or mucinous lesions. However, in most cases, ovarian cancer is a cystic mass with a solid component. Mucinous cancer is usually unilateral, and CA-125 levels may be slightly elevated. Endometrioid and clear cell carcinomas are associated with ovarian or pelvic endometriosis in 15–50% of cases. Non-epithelial neoplasms of the ovaries are rare and include germ cell tumors and germ cell tumors. The latter include granulosa cell tumors, fibromas, thecomas, and fibrothecomas. Germ cell tumors include mature and immature teratomas, dysgerminoma, choriocarcinoma, and yolk sac tumors. In general, malignant neoplasms of germ cells are extremely rare and are mainly found in children and young adults. A total of 5–15% of ovarian malignancies are ovarian metastases, mostly derived from primary tumors of breast, colon, or stomach cancer.

MRI DIAGNOSTICS OF MALIGNANT NEOPLASMS OF THE OVARIES

The main purpose of radiodiagnosis of ovarian tumors in women is the differentiation of benign and malignant processes. The data obtained will significantly influence the management of patients, which ranges from follow-up to determine the appropriate surgical approach (laparoscopy or laparotomy) or referral to a special oncology unit. Preoperative diagnosis will also identify a subgroup of women with benign lesions who may require long-term follow-up. For example, if a luteoma of pregnant women is suspected, the main diagnostic method will be MRI imaging.

Ultrasonography (US) has established itself as a first-line imaging modality for evaluating ovarian masses with excellent characteristics in benign cystic neoplasms, which account for the vast majority of all adnexal lesions. For the detection and characterization of adnexal masses, ultrasonography shows high sensitivity (88–100%) but not a wide range of specificity (39–87%). In a systematic review of 12 studies, the accuracy of I-mode ultrasound with complementary color Doppler for the preoperative diagnosis of ovarian cancer showed a sensitivity and specificity of 87% and 90%, respectively. However, sonographic evaluation of complex adnexal masses can be challenging, and in about 20% of cases, lesions must be classified as sonographically indeterminate due to their morphology or suboptimal ultrasonography. A study that prospectively compared US and MRI adnexal masses showed similar superior sensitivity

(100 vs. 96.6%, respectively) but higher MRI specificity (39.5 vs. 83.7%) in distinguishing malignant from benign lesions. Thus, MRI is particularly useful for indeterminate masses on ultrasound in women at low risk of malignancies in the clinical setting. For unambiguously malignant lesions on ultrasound, the next diagnostic step should be CT staging in accordance with the European Society of Urological Radiology (ESUR) guidelines.

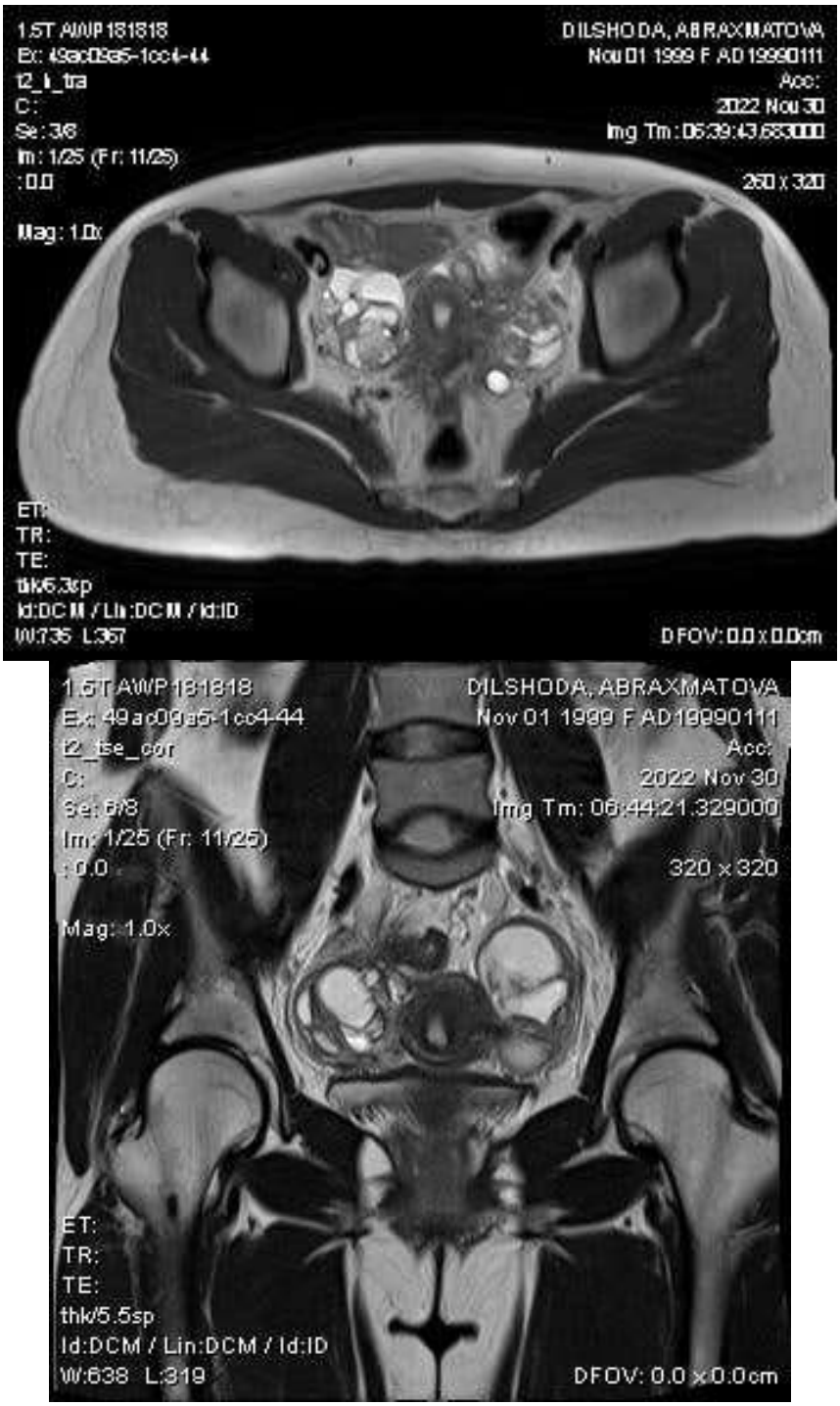

Figure 1. Axial and frontal sections on MRI. Dermoid cyst of both ovaries. In both ovaries, multi-chamber cysts 45x44, 58x45 mm in size with heterogeneous contents, cystic degeneration in the structure are determined.

In characterizing adnexal lesions, CT is limited in the diagnosis of adnexal solid tumors and in the evaluation of endometriomas. However, it provides accurate diagnosis of classic dermoids as well as benign and malignant cystic adnexal lesions. MRI can predict the histological nature of various benign adnexal masses, including teratomas, cysts, endometriomas, ovarian stromal tumors containing fibrous tissue, and uterine leiomyomas. It can reliably diagnose fatty and hemorrhagic lesions that can be difficult with ultrasound. Chemical shift imaging aids in the diagnosis of lean fatty dermoids, which are commonly misdiagnosed on CT and ultrasound. Tissue composition and microvascularization information obtained by DWI and DCE-MRI may facilitate the distinction between benign and malignant adnexal solid masses. In a study analyzing 77 complex adnexal masses, all low SI solid masses on DWI on high b-value images were benign.

While qualitative DWI with visual signal assessment at high b-values is increasingly being used to characterize the lesion, the value of ADC quantification is currently limited. This is mainly due to the wide overlap in ADC values between benign and malignant adnexal lesions. Pitfalls include low cell density malignant tumors such as mucinous tumors, borderline tumors, and solid benign tumors. The wide range of ADCs is also explained by the wide histomorphological variability of adnexal tumors and the presence of calcification, necrosis, and mucinous components. This is why, to avoid errors, DWI must be analyzed in the context of standard MRI sequences. A malignancy risk index including CA-125, menopausal status, and ultrasound findings was used to predict the likelihood of adnexal malignancy. The risk of a malignancy index less than 25 is associated with a 3% chance of malignancy, and the risk of a malignancy index of more than 250 is associated with a 75% chance of malignancy. A prospective study (n = 180) showed that additional specialized ultrasound and MRI served as a useful discriminator for correct referral to the oncology department, with sensitivity and specificity for ultrasound of 100% and 57%, respectively, and for MRI 92% and 86%. , respectively, for malignancy.

MRI is limited in the correct diagnosis of some rare benign adnexal tumors with solid and cystic components mimicking malignancy (eg, carcinoids, ovarian struma, cystadenofibromas, or Brenner tumors) and rare inflammatory lesions (eg, actinomyosis). Misdiagnosis can also be technique-related, for example if short TI inversion recovery sequences are used for fat suppression or chemical shift imaging is not performed in low-fat tumors. There are only limited data on the study of MR spectroscopy to characterize adnexal masses. Proton MR spectroscopy has shown potential in differentiating lesions. Due to many technical problems and overlapping spectral patterns of 1H-MR for different histological subtypes, its clinical value has not yet been established, and others have found an intense lipid peak in ovarian malignancies but not in benign epithelial tumors, however overlap has been noted with some benign teratomas . The absence of lactate peaks was an excellent predictor of benign adnexal tumors. At 3 T, a choline/creatine ratio greater than three predicted malignancy. In contrast, the absence of a choline signal or a choline/creatine ratio of less than 1.5 was indicative of a benign tumor. The latter was found in six out of seven patients with benign tumors.

MRI SIGNS OF MALIGNANT OVARIAN TUMORS

Over the past two decades, MRI features similar to those used in ultrasound and CT have been proposed to predict malignancy. A recent meta-analysis including 1267 ovarian neoplasms from 18 MRI studies showed a sensitivity of 92% and a specificity of 85% (area under the curve = 0.95) for the detection of invasive and borderline ovarian cancer. For these tumors, the pretest probability of cancer increased from 34% overall to 78% with a positive result for malignancy and decreased to 5.1% with a negative result [18]. Findings suggestive of malignancy include the presence of a solidly enhanced lesion or a solid-cystic structure with thick septa (>3 mm) and/or papillary prominences and a lesion larger than 4 cm (Figure 2). A diameter greater than 5–6 cm, combined with complex architecture, also increases the likelihood of adnexal malignancy. Frequently used secondary features include the presence of peritoneal, mesenteric, or omental metastases, invasion of the pelvic lateral wall, and lymphadenopathy. These features increase confidence in the diagnosis of malignancy**.**

The most prognostic signs of malignancy are vegetations in a cystic lesion of the appendages, necrosis in a solid lesion, and the presence of ascites. Pelvic ascites can also be found in inflammatory disease or as a physiological phenomenon in premenopausal age. A large amount of ascites combined with adnexal mass usually indicates advanced ovarian cancer. Meigs syndrome, consisting of a solid ovarian stromal tumor associated with ascites and pleural effusion, may mimic advanced ovarian cancer. Integration of perfusion kinetics or tissue composition may sometimes be necessary to correctly diagnose lesions that are difficult to assess with conventional MRI. Thomassin-Naggara et al. found that for combined morphological MRI and DWI, the most predictive signs of malignancy were the presence of papillary projections (likelihood ratio [PLR] = 4.5), high SI on DWI with b values of 1000 sec/mm2 in the solid component (PLR = 3.1), intermediate SI on T2-weighted image of the solid component (PLR = 2.2), ascites and peritoneal implants (PLR = 2) and solid (PLR = 1.8) (Fig. 2). In solid and complex adnexal cystic and solid tumors, all malignant tumors, as well as some borderline tumors, showed a high SI with a high b-value in DWI. Because conventional MRI can accurately predict malignancies, additional DWI seems to be most useful in solid lesions and when contrast-enhanced MRI is not possible due to contrast agent contraindications such as allergies or renal failure.

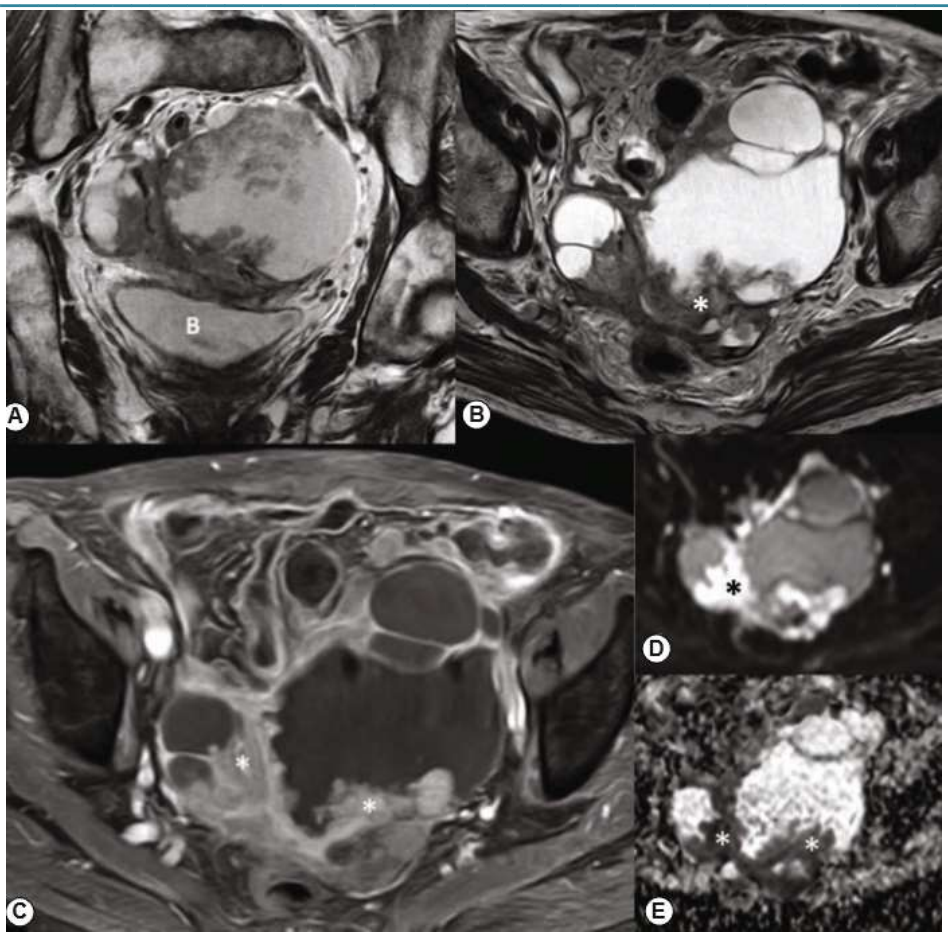

Figure 2. Serous ovarian cancer in a 75-year-old woman. (A) A complex cystic and solid adnexal mass is demonstrated on coronal and (B) transaxial T2-weighted imaging. Enhancement of hard aspects and papillary projections (asterisks) on (C) T1-weighted contrast-enhanced MRI and (d) high signal on the corresponding diffusion-weighted image with high b value and (e) signal with low apparent diffusion coefficient are typical features, suggestive of malignancy (asterisks). B: Bladder.

Another approach to improve the characterization of adnexal masses is the analysis of microvascular properties using DCE-MRI. Patterns of early enhancement in 41 epithelial ovarian tumors correlated with tumor angiogenesis. Early enhancement was noted in invasive ovarian cancer and was higher than in benign($p < 0.001$) and borderline tumors ($p < 0.05$). Another group reported the benefits of a cut-off value of over 2.35 over psoas obtained within the first 120 s for correct adnexal classification. Moreover, information on perfusion and tissue composition may be useful for making a correct diagnosis, for example, in women with adnexal tumors who wish to maintain fertility [11]. The addition of DWI and DCE-MRI reduced the number of false positives, and all false negatives were eliminated in 87 women with complex adnexal masses.

CONCLUSION

Due to the modern approach and changes in the treatment of ovarian cancer, imaging has become an integral and key part of the treatment. MRI has different roles for patients with an indeterminate ovarian tumor compared with patients with clinically obvious ovarian cancer confirmed by ultrasound. In the first case, MRI plays a large and constantly evolving role in problem solving. Advances in the integration of functional MRI, including DWI and DCE-MRI, hold the promise of further improved performance to confidently diagnose the vast majority of complex adnexal masses. This is especially helpful in the elderly to avoid unnecessary surgery, and in younger women with a low chance of ovarian cancer and when surgery is not desirable. In women with malignancies, CT is currently recommended for comprehensive preoperative staging. Although evidence suggests that MRI is superior to CT in some cases, due to practical issues such as exam time and multiple contraindications (ferrometals, pacemakers, etc.), as well as spatial resolution limitations to cover large fields vision interfere with its routine use in staging ovarian cancer. Before proceeding with functional MRI in routine imaging, it is necessary to optimize and standardize protocols and analysis methods. In addition, the training of radiologists should be aimed at a deep understanding not only of the anatomy and morphology of the disease, but also knowledge of metabolic pathways, in particular those that are relevant to functional imaging. The functional qualitative and quantitative properties obtained with MRI or its combination with advanced techniques such as nanotechnology raise hopes that the role of MRI may shift from problem solving to a centralized management tool. The combined interpretation of morphological and functional data promises to increase the efficiency of visualization of small metastases. Quantitative MRI with DWI or DCE-MRI holds promise as a biomarker of tumor composition, response, and

prognosis. However, the value of these new techniques, including comparison with PET/CT, needs to be confirmed by histopathological correlation in multicentre studies.

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