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The Role of Radiological Examinations in The Diagnosis of Endometriosis (Literature Review)

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Abstract

Endometriosis is one of the most common chronic gynecological diseases affecting women of reproductive age and is characterized by the presence of endometrium-like tissue outside the uterine cavity. The disease is commonly associated with chronic pelvic pain, dysmenorrhea, dyspareunia, and infertility, significantly impairing women's quality of life and reproductive health. In addition, depending on the localization of endometriotic lesions, the disease may present with diverse clinical manifestations and symptoms. The variability of clinical signs and the asymptomatic course observed in some cases complicate early diagnosis of endometriosis.

Timely detection and appropriate treatment of endometriosis require the use of radiological imaging methods, which represent a crucial diagnostic task. The application of these techniques contributes to improved patient quality of life and helps prevent disease-related complications.

The main radiological methods used in the diagnosis of endometriosis include ultrasound examination (US), magnetic resonance imaging (MRI), and less frequently contrast-enhanced computed tomography (CT). Transvaginal ultrasound demonstrates high sensitivity in the detection of endometriomas (ovarian endometriotic cysts) and is widely used as a first-line diagnostic modality in clinical practice. MRI plays a particularly important role in cases of deep infiltrating endometriosis (DIE), where endometriotic lesions invade adjacent structures such as the intestines, urinary bladder, ureters, and surrounding tissues, allowing for accurate assessment of disease extent and spread.

Radiological imaging is essential not only for the detection of endometriosis but also for evaluating the localization, size, complications of endometriotic lesions, adhesions, and associated anatomical changes. Furthermore, imaging techniques are of great importance in determining treatment strategy (medical or surgical), preoperative planning, and postoperative follow-up, making them indispensable tools in the clinical management of endometriosis.

Keywords: Endometriosis, diagnosis, ultrasound examination, magnetic resonance imaging, laparoscopy, chronic pelvic pain, deep infiltrating endometriosis.

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1. Introduction

Accurate assessment of the characteristics of endometriotic lesions is crucial for determining further treatment strategies and directly influences the prognosis of the disease. Although laparoscopy is currently considered the gold standard for the diagnosis of endometriosis [1], optimal diagnostic evaluation requires a multidisciplinary approach that integrates clinical examination, laboratory investigations, and modern imaging techniques.

Endometriosis may develop in various anatomical structures, including the ovaries. Ovarian endometriosis (endometrioma) often requires differential diagnosis with other ovarian pathologies. Therefore, radiological imaging plays a key role in identifying the morphological features of ovarian changes associated with endometriosis.

From an imaging-based perspective, ovarian changes related to endometriosis can be conditionally classified into monolocular cystic lesions, multilocular cysts, cystic-solid formations, and predominantly solid masses. Such classification facilitates systematic interpretation of radiological findings and contributes to more accurate differential diagnosis.

Magnetic resonance imaging (MRI) is an important diagnostic tool for identifying the origin of pelvic pathological processes, characterizing adnexal abnormalities, and detecting deep infiltrating endometriosis. The main advantages of MRI include high soft-tissue contrast resolution and the absence of ionizing radiation. Although different pathological conditions may present with similar radiological features, radiologists must be familiar with MRI signs specific to endometriosis, as this knowledge is essential for guiding differential diagnostic decisions.

Epidemiology

In terms of prevalence, endometriosis ranks after inflammatory diseases of the female genital organs and uterine myomas. According to data from the World Health Organization (2025), endometriosis affects approximately 10% of women of reproductive age worldwide, corresponding to more than 190 million women. The disease is most commonly observed in women aged 15–49 years, while among women seeking medical care for infertility, the prevalence increases to 25–50% [2].

Regarding distribution, genital endometriosis accounts for 92–94% of cases, whereas extragenital endometriosis constitutes 6–8% [3]. Among genital forms, ovarian endometriomas occur in 17–44% of cases and are better visualized on ultrasound examination compared with other types of endometriosis [4,5]. Histopathologically confirmed adenomyosis has a prevalence of 15–31% [6]. Endometriotic involvement of the fallopian tubes is reported in approximately 14.48% of cases [7].

Intestinal endometriosis is observed in 3–37% of women with endometriosis. The most frequently affected segment is the rectosigmoid colon (70–93%), followed by the ileocecal region, appendix, and other segments of the large and small intestines [8].

Etiopathogenesis

The exact etiology and pathogenesis of endometriosis remain incompletely understood. Throughout the 20th century, several theories were proposed to explain the development of endometriosis. Although each theory elucidates certain aspects of the disease, no unified concept has yet been established. In recent years, advances in molecular biology, immunology, and genomics have provided new insights into the mechanisms underlying endometriosis.

Currently, the most widely recognized theories and contributing factors include:

Retrograde menstruation theory (Sampson, 1927);

Coelomic metaplasia theory;

Benign metastasis (lymphatic and hematogenous spread) theory;

Iatrogenic implantation theory;

Embryogenesis and migratory cell theory;

Immunological and inflammatory factors;

Genetic and epigenetic factors [9].

Classification

Since the introduction of the term “endometriosis” in scientific literature, more than 30 different classification systems have been proposed for this disease. Endometriosis is considered one of the most heterogeneous (various) conditions in terms of clinical presentation and disease course; therefore, a single universally accepted classification has not been established [10].

The most commonly used clinical classifications are based on disease localization. Accordingly, endometriosis is divided into genital and extragenital forms.

1. Genital Endometriosis

This form is characterized by endometrioid involvement limited to the reproductive organs and includes:

1.1 Internal genital endometriosis — characterized by the proliferation of endometrioid tissue within the uterine body, isthmus, and interstitial portions of the fallopian tubes.

1.2 External genital endometriosis — involves the external genital organs, vagina, vaginal portion of the cervix, ovaries, fallopian tubes, retrocervical region, and the peritoneum of the pelvic cavity.

External genital endometriosis, in turn, is classified in relation to the peritoneum into:

1.2.1 Peritoneal endometriosis — affecting the ovaries, fallopian tubes, and pelvic peritoneum;

1.2.2 Extraperitoneal endometriosis — involving the external genital organs, vagina, cervix, and retrocervical region.

2. Extragenital Endometriosis

This form is characterized by endometrioid lesions affecting organs outside the reproductive system [11].

Staging of Endometriosis for assessment of disease severity and extent, the ASRM/rASRM staging system are commonly applied. The most widely used and clinically accepted system is the Revised American Society for Reproductive Medicine classification (rASRM, 1996). This system evaluates the extent of endometriotic lesions and adhesions using a scoring system and divides the disease into four stages:

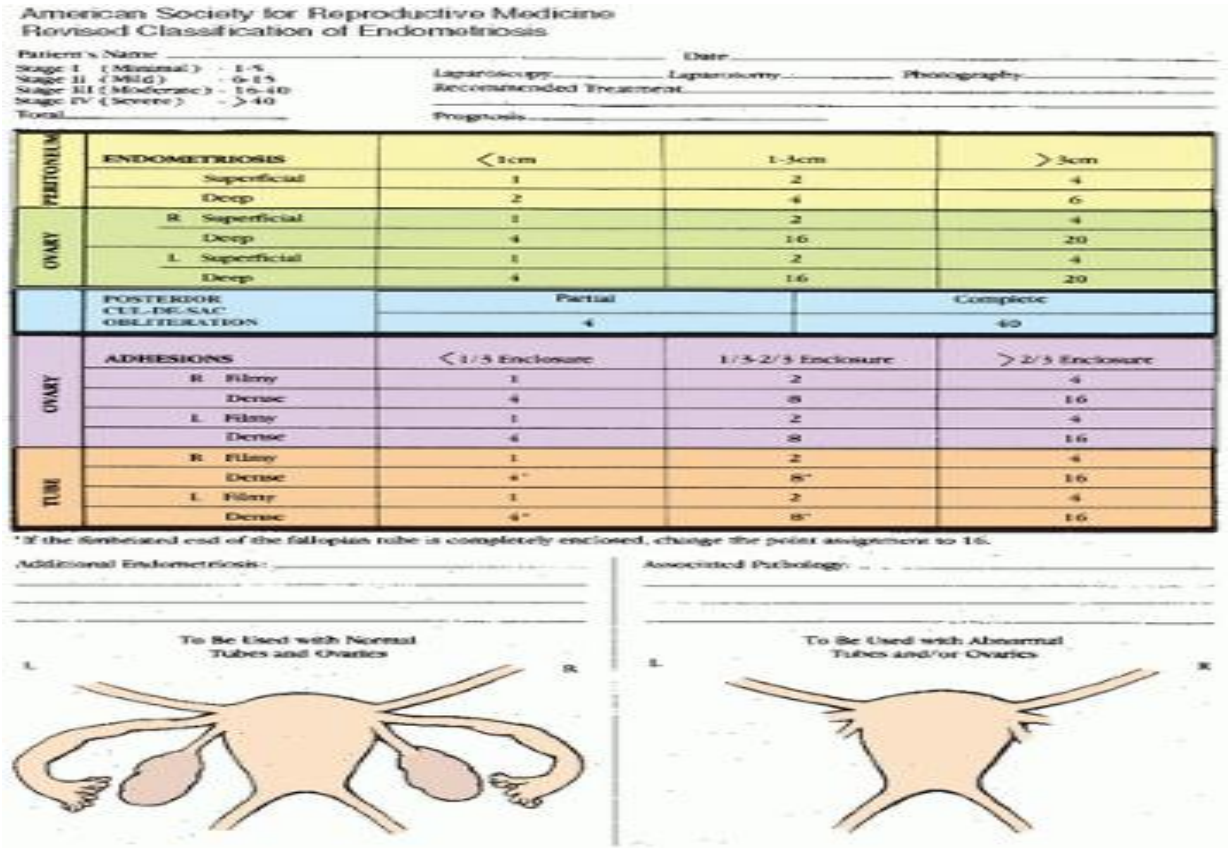
Stage I — minimal

Stage II — mild

Stage III — moderate

Stage IV — severe (Figure 1)

Figure 1



One of the main advantages of the rASRM classification is that it is internationally accepted and has been widely used in recent years. In addition, it is easy to apply and helps clinicians explain the severity and extent of endometriosis to patients in a simple and comprehensible manner [12].

The American College of Obstetricians and Gynecologists (ACOG) also recommends the use of the rASRM classification in the description and assessment of endometriosis.

ENZIAN Classification

Deep infiltrating endometriosis (DIE) represents one of the most severe clinical forms of endometriosis and remains among the most diagnostically challenging variants. In this condition, endometriotic lesions infiltrate tissues at a depth of 5 mm or more beneath the peritoneal surface and frequently involve the intestines, uterosacral ligaments, rectovaginal septum, and organs of the urinary tract [13].

To enable standardized assessment of deep infiltrating endometriosis, the ENZIAN classification was developed. This system allows classification of the disease based on anatomical localization and depth of infiltration [14].

Structure of the ENZIAN Classification

The ENZIAN classification (Figure 2) is based on the traditional ENZIAN system used for deep endometriosis (DE) and includes three main compartments:

A — vagina and rectovaginal space (RVS);

B — uterosacral ligaments (USL) / cardinal ligaments / lateral pelvic wall;

C — rectum.

In addition, so-called F compartments (distant locations) are included, such as:

FB — urinary bladder;

FU — ureters;

FO — other extragenital endometriotic lesions.

The classification also accounts for:

Peritoneal involvement (P);

Ovarian involvement (O);

Other intestinal segments (sigmoid colon, small intestine; FI);

Adhesions involving the tubo-ovarian unit (T), with optional assessment of tubal patency.

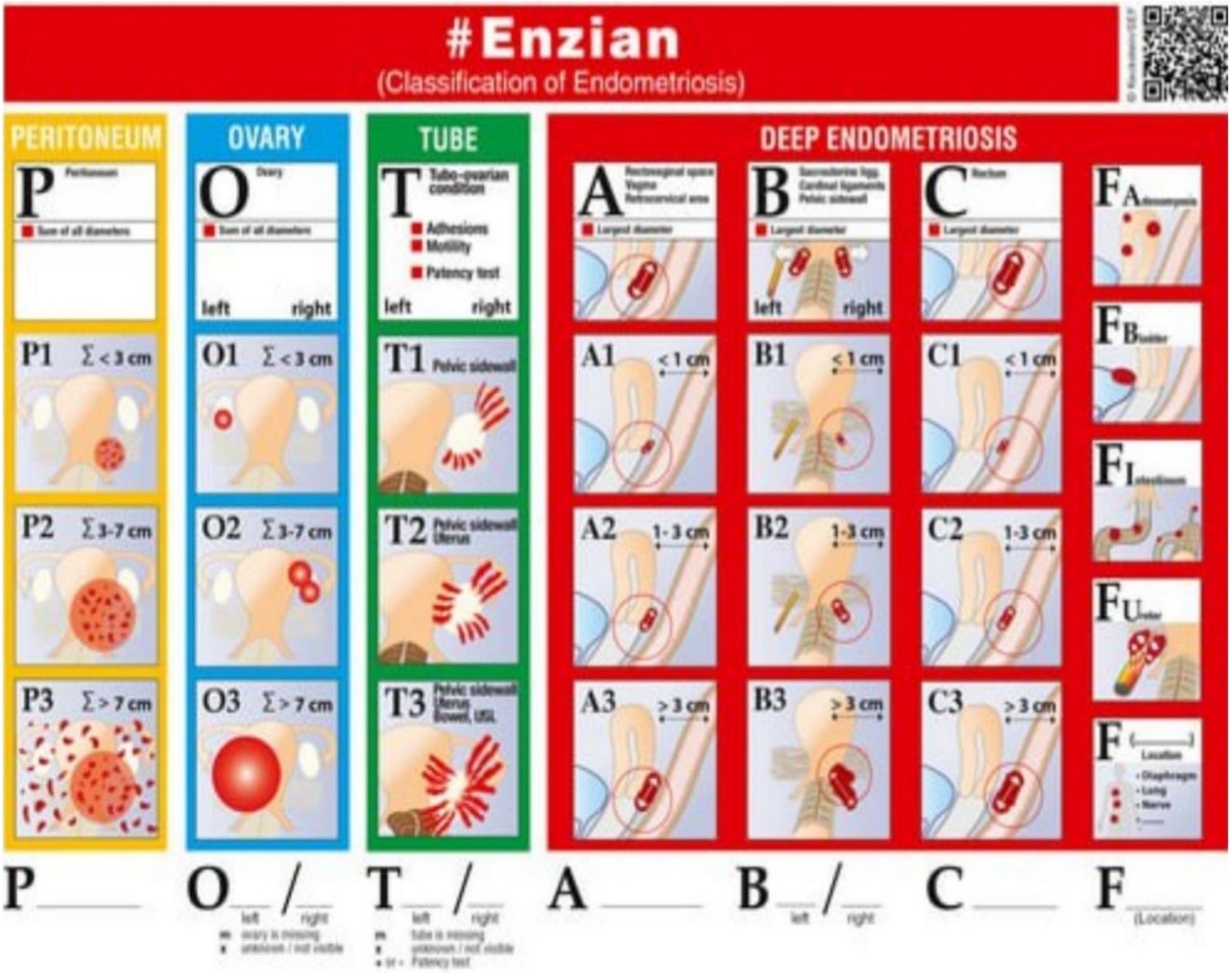
Individual compartments or affected organs are denoted by capital letters (P, O, T, A, B, C, F) and listed in this order.

The severity of endometriosis in compartments P, O, T, A, B, and C is graded using numerical values 1, 2, and 3, reflecting increasing lesion size and depth.

For paired organs (ovaries, fallopian tubes, uterosacral ligaments, parametrial regions, and ureters), the degree of involvement is specified separately for the left and right sides.

Absent or non-visualized ovaries or fallopian tubes are indicated using additional markers: m — missing, x — unknown [15].

Figure 2



Diagnostic and Clinical Significance of the ENZIAN Classification

The diagnostic and clinical significance of the ENZIAN classification lies in its ability to improve the accuracy of ultrasound and MRI detection of deep infiltrating endometriosis, support surgical planning, and ensure a unified terminological approach in scientific research. Compared with the ASRM system, the ENZIAN classification provides greater anatomical precision and demonstrates particular advantages in the assessment of deep infiltrating forms of endometriosis.

Grading

According to Morphological Forms:

Nodular form — characterized by well-defined lesion margins;

Focal (diffuse) form — characterized by irregular and poorly defined borders.

According to the Extent of Internal Endometriosis

Grade 1 — depth of invasion 0.2–0.3 cm, not exceeding one-third of the myometrial thickness;

Grade 2 — involvement up to one-half of the myometrial thickness;

Grade 3 — involvement of more than one-half of the myometrium (adenomyosis);

Grade 4 — extrauterine spread with involvement of the parietal pelvic peritoneum and adjacent organs.

Classification of Retro-cervical Endometriosis

Stage I — localization of endometrioid lesions within the rectovaginal tissue;

Stage II — infiltration of the cervix and vaginal wall with formation of small cysts;

Stage III — extension of the pathological process to the uterosacral ligaments and the serosal layer of the rectum;

Stage IV — involvement of the rectal mucosa, spread to the peritoneum of the rectouterine pouch, and formation of adhesions in the adnexal region [16].

Diagnostic Imaging

Diagnostic imaging plays a crucial role in the detection of endometriosis and in assessing its forms and extent of spread. Radiological examinations are particularly important in the diagnosis of ovarian endometriosis (endometriomas) and deep infiltrating endometriosis.

Ultrasound examination (US) is considered the first-line diagnostic modality in patients with suspected endometriosis due to its wide availability, non-invasive nature, and good patient tolerance. Transabdominal and, especially, transvaginal ultrasound enable the detection of ovarian endometriomas, which typically present as homogeneously hypoechoic lesions with fine internal echoes and a characteristic "ground-glass" appearance [4,17,18]. On color Doppler imaging, endometriomas usually demonstrate minimal or absent vascularity, which serves as an important feature for differentiation from other cystic ovarian lesions [19].

In cases of inconclusive ultrasound findings or suspicion of deep infiltrating endometriosis, additional imaging modalities are recommended. Although computed tomography (CT) has limited diagnostic value in the primary detection of endometriosis, it may serve as an adjunctive method in complex cases, particularly when intestinal, urinary tract, or other extragenital organ involvement is suspected [20].

Magnetic resonance imaging (MRI) is one of the most informative modalities for the detection and differential diagnosis of endometriosis. MRI allows precise assessment of lesion localization, depth of infiltration, and extension to adjacent anatomical structures. The main advantages of MRI include high spatial resolution, excellent soft-tissue contrast, and the absence of ionizing radiation, which is particularly important for women of reproductive age [21,22].

MRI evaluation of endometriosis is based on T1- and T2-weighted sequences. Fat-suppressed T1-weighted images are highly valuable for identifying hemorrhagic components and are considered characteristic of endometriomas. On T2-weighted images, the "T2 shading" phenomenon is commonly observed, reflecting a high concentration of blood degradation products [23,24] (Table 1). In selected cases, contrast-enhanced imaging may aid in evaluating fibrotic components and refining differential diagnosis.Diffusion-weighted imaging (DWI) represents an additional MRI component and may demonstrate diffusion restriction in endometriomas due to their viscous hemorrhagic content. However, DWI findings should always be interpreted in conjunction with conventional T1- and T2-weighted images, as similar features may also be observed in other benign cystic lesions [25,26].

		MR/CT Sign	MRI/CT Findings
Ovary	Ovarian endometrioma	T1-high signal multiplicity	Multiple high signal cysts on T1WI
		T2-Shading	Marked T2 shortening or gradations on T2WI
		T2 dark spot sign	Discrete well-defined markedly

		MR/CT Sign	MRI/CT Findings
			hypointense foci within the cyst on T2WI
	Decidualization		Linear, broad-based nodular, or polypoid structures with high SI similar to placental tissue on T2WI
	Polypoid endometriosis		Polypoid mass, slightly high SI similar to endometrium on T2WI
			Punctate high signal foci on T1WI
			Peripheral rim by fibrous tissue on T2WI
			Strong enhancement on contrast enhanced-T1WI

		MR/CT Sign	MRI/CT Findings
			Small cysts on T2WI
	EAOC		Emergence of enhanced mural nodules within the ovarian endometrioma
			Increased tumor size (> 9 cm)
			(suggestive) Dissapearance of shading on T2WI
DIE			Hypointense nodular lesions (T1/T2WI)
			Soft tissue thickening with irregular, indistinct, or stellate margins (T1/T2WI)
	Posterior cul-de-sac obliteration (pouch of		Retroflexed uterus
			Elevated posterior vaginal fornix on T1/T2WI

		MR/CT Sign	MRI/CT Findings
	Douglas, rectouterine/ retrovaginal space)		Intestinal tethering or tethered appearance of rectum in the direction of the uterus on T2WI
			Faint strands between the uterus and intestine on T2WI
			Fibrotic plaques or nodules covering the serosal surface of the uterus on T2WI
			Retrouterine fibrous mass on T2WI
			Intraperitoneal fluid displacement
	Torus uterinus, USL		T2-low intensity thickening or mass with regular or irregular margins on MRI

		MR/CT Sign	MRI/CT Findings
	Ovary	Kissing ovary	Bilateral ovaries are located in the posterior cul-de-sac or at the cornua of the uterus on MRI
	Round ligament		Thickened and irregular with a nodular appearance on MRI
	Rectosigmoid colon	'Fan shaped'/'mushroom cap'	Focal thickening of the rectal wall as an umbrella-like head of a mushroom on MRI
	Bladder endometriosis and vesicouterine space		Hypointense nodular formation on T1/T2WI
Extra-pelvic endomtriosis	Abdominal wall endometriosis	Gorgon' sign	On CT, homogeneous density Linear infiltration irradiating

		MR/CT Sign	MRI/CT Findings
			peripherally from a central soft tissue nodule on CT On MRI, hypointense solid mass on T2WI with/without hyperintense hemorrhagic cysts on T1WI
	Diaphragmatic endometriosis		Hyperintense nodule on T1WI, mostly right side

DIE = deeply infiltrating endometriosis, EAOC = endometriosis associated ovarian carcinoma, SI = signal intensity, T1WI = T1-weighted image, T2WI = T2-weighted image, US = ultrasonography, USL = uterosacral ligament

[33]

In recent years, the use of 3 Tesla (3T) MRI systems has become increasingly widespread. These systems provide a higher signal-to-noise ratio, improving the detection of small endometriotic lesions and playing an important role in the early diagnosis of the disease [27,34].

The figure illustrates an ovarian endometriotic cyst in a 42-year-old woman who presented with complaints of abdominal pain [33].

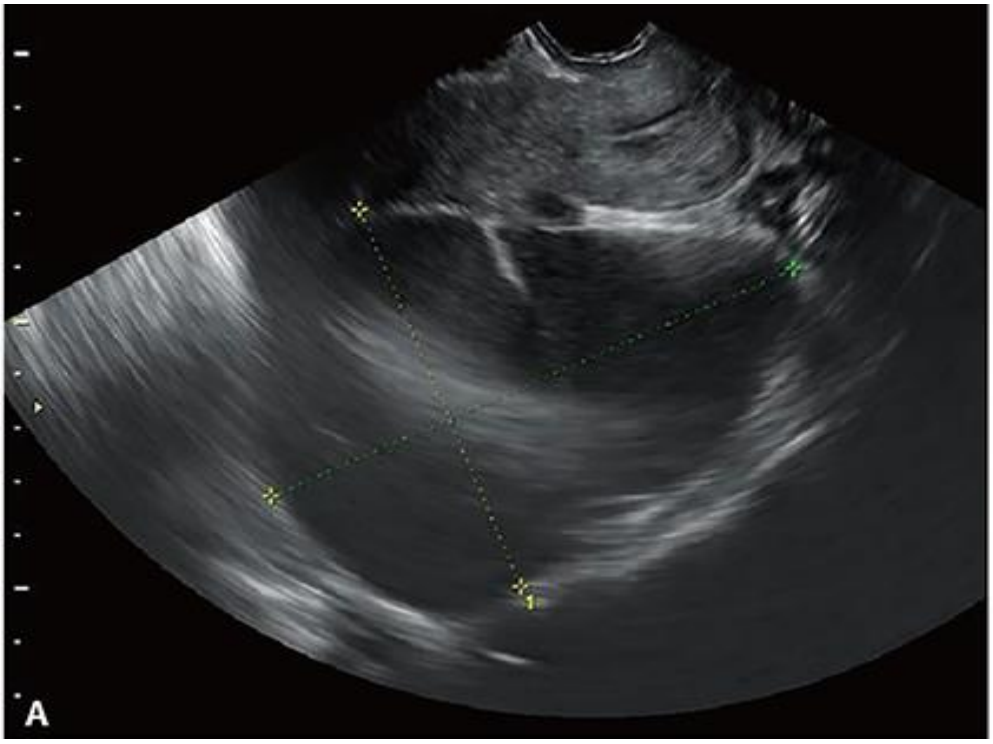
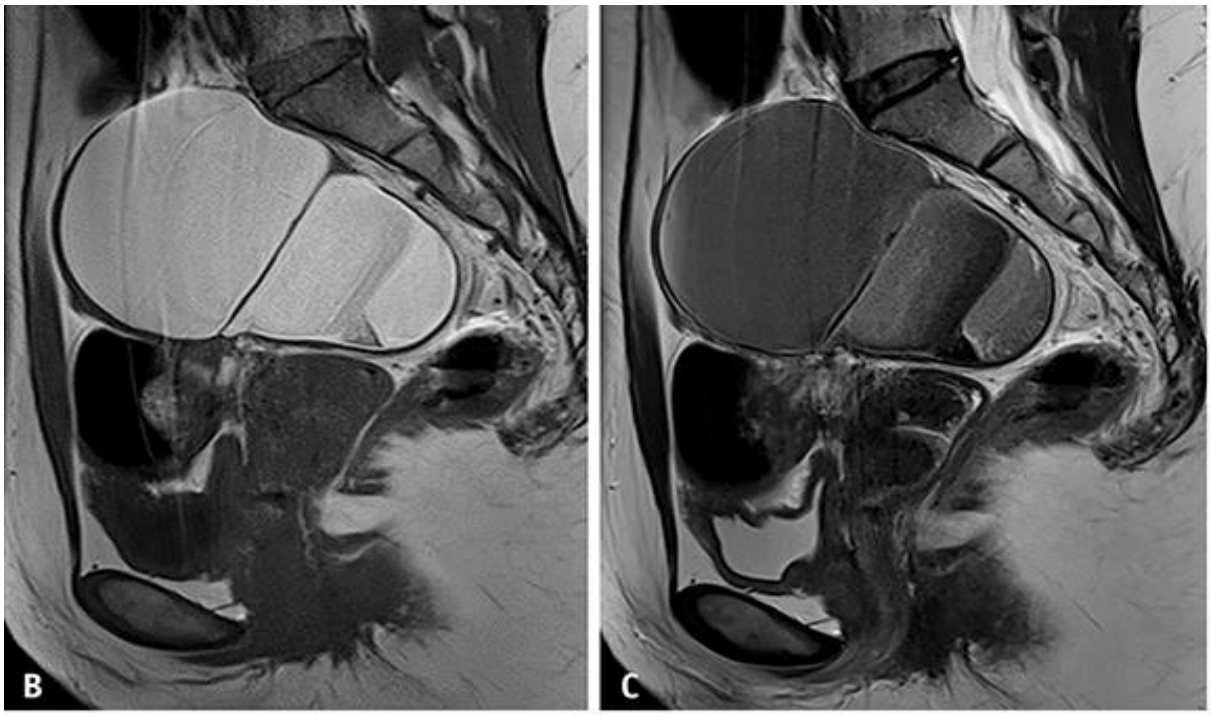


Figure description

A. Transvaginal ultrasound demonstrates a cystic lesion with low echogenicity located posterior to the uterus, containing mixed hyperechoic areas. Small internal septations are visualized within the lesion.



B, C. Sagittal T1-weighted (B) and sagittal T2-weighted (C) MRI images. On MRI, the ovarian endometriotic cyst appears hyperintense on T1-weighted images and shows heterogeneous signal intensity reduction on T2-weighted images, manifested as the characteristic "T2 shading sign."[33].

2. Conclusion

Endometriosis is frequently diagnosed at advanced stages due to the nonspecific nature of its clinical manifestations, which may lead to disease progression and impairment of reproductive function. In this context, the role of radiological imaging in the diagnosis of endometriosis has become increasingly significant.

Analysis of the literature indicates that ultrasound examination is an effective first-line diagnostic modality for detecting ovarian endometriosis, distinguished by its wide availability and high diagnostic performance [28,29]. However, in cases of deep infiltrating endometriosis and anatomically complex localizations, the diagnostic capabilities of ultrasound may be limited.

Magnetic resonance imaging is recognized as a highly accurate method for identifying complex forms of endometriosis and for assessing the localization and extent of pathological lesions. MRI-derived information enhances the accuracy of differential diagnosis, facilitates planning of surgical interventions, and plays a crucial role in selecting optimal treatment strategies [30–32].

Thus, radiological examinations should not be regarded as independent diagnostic tools but rather as an integral component of a comprehensive diagnostic approach that complements clinical and laboratory assessments. The widespread implementation of modern radiological technologies in clinical practice contributes to early diagnosis, effective treatment, and improved quality of life for patients with endometriosis.

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