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Imaging Tools for Endometriosis: Role of Ultrasound, MRI and Other Imaging Modalities in Diagnosis and Planning Intervention

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1. Introduction

Endometriosis is the presence of endometrial glands as well as stroma at the locations outside uterus. It affects up to 10% of women. Grossly there are three forms of the disease, namely a) superficial endometrial implants, b) ovarian endometriomas or endometriotic cysts, and c) deep infiltrating endometriosis. All the three forms depict varied manifestation of a single disease and require a careful pre operative work up to know the extent and distribution of the disease precisely as it is critical to frame the plan of management.

The superficial implants are typically 2-3 mm in size rooted in the serosal tissue of the peritoneum. They initially appear as red highly vascular lesions. Later, repeated haemorrhage and inflammation triggers fibrosis and haemosiderin deposition in them causing raised powder burn lesions. It is hard to find such lesions by USG or MRI. Traditional method of diagnostic endoscopy still remains the golden standard of reference to diagnose and stage this form of disease.

Endometriomas of the ovary or chocolate cysts of the ovary contain degraded blood products. The dark and gelatinous material in them is surrounded by fibrous wall of variable thickness. Endomeriotic cysts are often bilateral and multiple. Both the USG and MRI play key role in its evaluation.

The deep infiltrating endometriosis (DIE) is defined as the implant penetrating into the retroperitoneal space or the wall of the pelvic organs to the depth of at least 5mm. (Knoninckx et al). They usually appear as solid nodules. These types of lesions permeate deep into the surrounding fibromuscular tissues and induce smooth muscle proliferation and fibrous reaction effecting development of solid nodules. In case of visceral involvement, they can infiltrate into the muscle layer from the serosal layer. The resulting smooth muscle proliferation can lead to stricture formation and later obstruction.

2. Natural history of the disease

The natural history of the symptomatic disease is uncertain. The lesions may either continue to be same or may evolve further or may regress. Its malignant transformation is uncommon

and its exact incidence is not known. This is diagnosed only if there is no evidence of metastasis from any primary sites and the surrounding tissue has presence of benign as well as the malignant endometrial tissue.

3. Locations

The disease most commonly affects the ovaries and the pelvic peritoneum. DIE classically affects the rectovaginal septum and the uterine ligaments (69.2%), the vagina (14.5%), the rectosigmoid bowel (9.9%), and the bladder and ureter (6.4%) in the order of frequency. Rarely lungs and CNS may be involved.

4. Diagnostic modalities for evaluation of endometriosis

The diagnosis of endometriosis is conventionally made by laparoscopy but over the time the imaging techniques have evolved to greatly facilitate the pre operative diagnosis. Further laparoscopy has limited role in visualizing atypical non pigmented extraperitoneal sites of involvement and the areas especially concealed by pelvic adhesions.

By and large ultrasound is the first preliminary investigation done to assess the pelvic disease in reproductive age group. Although it has limited role in detection of superficial implants, it is useful in the diagnosis and treatment of endometriomas. MRI provides a good alternative with high specificity and sensitivity for detecting deep infiltrating (DIE) endometriosis as well as endometriomas. The main drawback of MRI is again inability to detect small peritoneal infiltrates (< 3mm). Introduction of fat saturated T1 weighted image on MRI has consistently improved its accuracy in distinguishing between ovarian mass with lipids from endometriomas.

Computed tomography usually gives ill defined results, thus is not very helpful. Conventional investigations like barium enema or intravenous urography may prove useful in detection of visceral endometriosis. Their use however is limited in current practice due to excessive radiation dose.

Further sections of this chapter will first discuss the various imaging modalities in detail followed by the characteristic appearance of diverse typical and atypical forms of endometriosis.

4.1 Ultrasound

Ultrasound as discussed is usually the first investigation done in subject suspected of any pelvic disease. USG has the advantage of having good resolution, easy accessibility, less expensive, and is free of ionizing radiation. Three modes are available- transabdominal, transvaginal and endorectal scanning.

For transabdominal scanning 3-5 MHz convex probe is used. Full bladder is must for this technique in order to properly visualize the uterus and the ovaries. It is very useful in cases of suspected bladder involvement and abdominal wall endometriosis. Kidneys should be examined for hydronephrosis

Transvaginal scanning (TVS) is done with probe of high frequency 6-7.5MHz positioned in vagina. Full bladder is not a pre requisite for this mode of USG and procedure is well

accepted by most of the patients. TVS has superior image quality and resolution as compared to TAS. Thus it has high sensitivity (92%) and specificity (99%) in detecting endometriomas. The typical ultrasound findings include a cystic mass with diffuse, low-level echoes (figure 1).

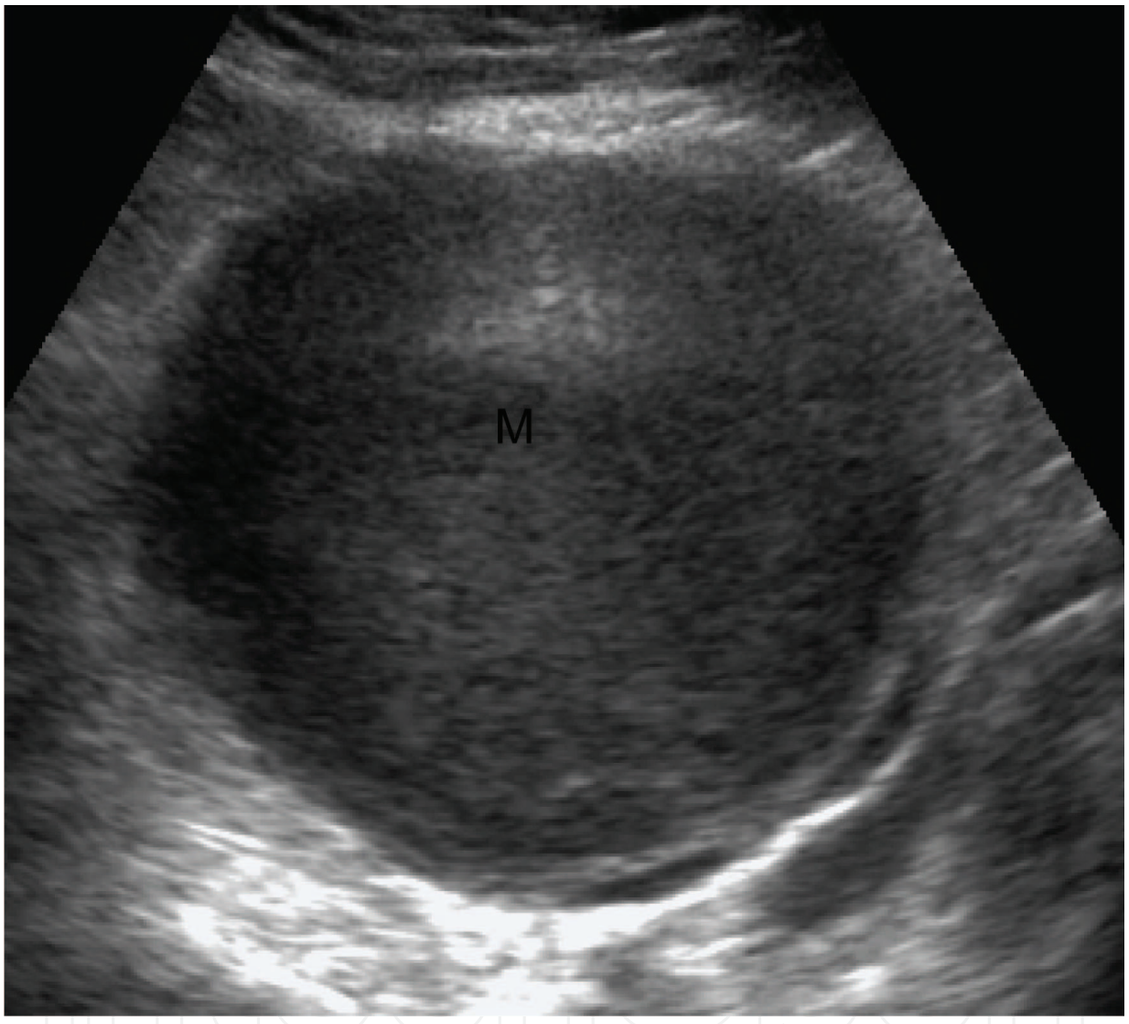

Fig. 1. Grey-scale Transvaginal ultrasound of an endometrioma(M). Note the characteristic diffuse, low-level echoes of the endometrioma giving a solid appearance

Depending on the age of the haemorrhage, the contents of the cyst, may vary in appearance. At times, an endometrioma may resemble a cystic-solid or entirely solid mass. Punctate echogenicities in the wall of endometriomas are less commonly seen but add specificity to the diagnosis. Endometriomas can be multilocular with internal thin or thick septations and thick irregular walls. Mild vascularity may be identified on color Doppler (figure 2). Color Doppler US shows no blood flow in the fine septations, whereas blood flow can often be detected in thick septations because of revascularization of chronic haematoma. Internal moving echos within endometrioma may reveal color signal.

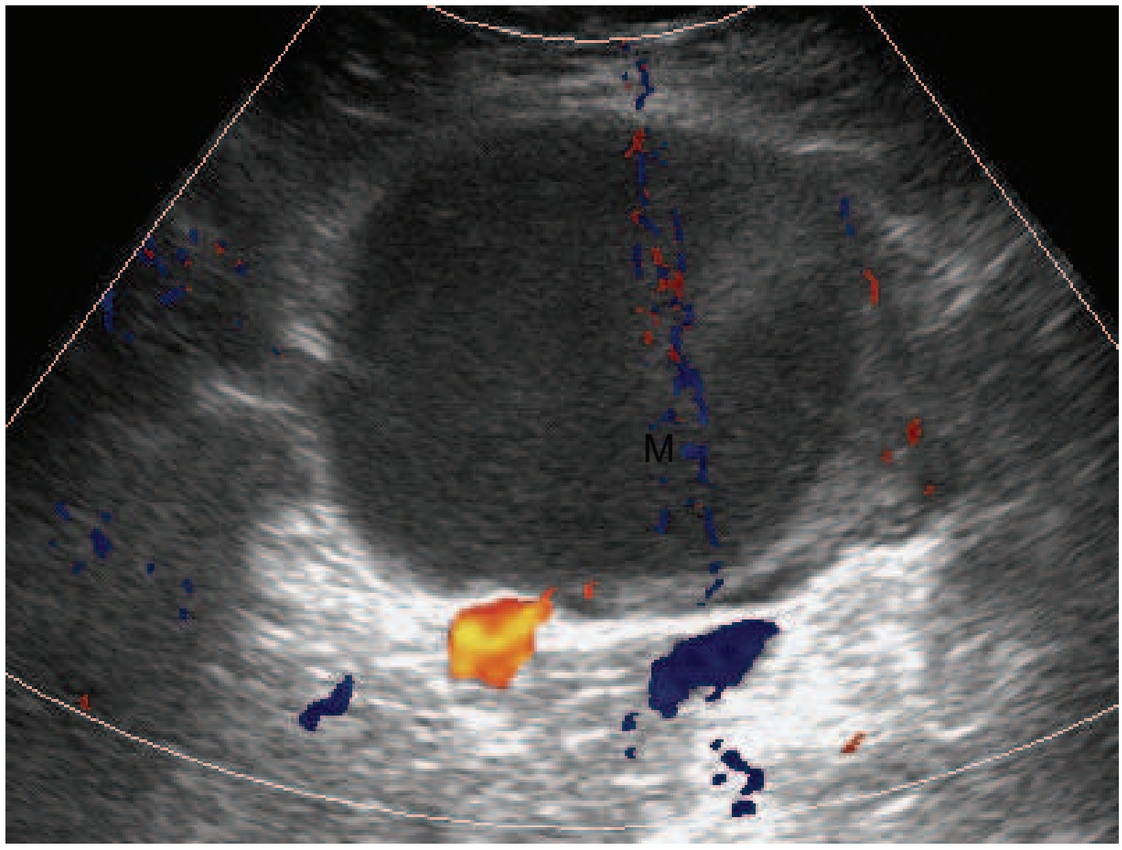

Fig. 2. Transvaginal ultrasound of an endometrioma color Doppler image showing mild peripheral vascularity. Internal color signals are likely related to moving internal echos.

Spectral Doppler reveal low-resistance waveforms which may not be helpful in differentiating endometriomas from other masses including malignancy.

Transrectal sonography uses biplane convex flexible rectal probe of 6.5MHz. The probe is flexible and can be advanced into the sigmoid colon to look for any signs of invasion by endometriosis. Patient preparation with rectal enema is required before endorectal sonography. The rectum and the surrounding area in the perimetry show five alternating hyper and hypoechoic layers respectively. The endometriotic deposits are visualized as triangular or round hypoechoic lesions on transrectal USG. It is superior to MRI with reported high sensitivity and specificity of 97% and 80%.

4.2 Magnetic resonance imaging

MRI is a non invasive intervention by which whole pelvis can be visualized in different planes. It can be very useful in patients in whom ultrasound findings are equivalent and in carefully selected high risk population. It is especially beneficial in identifying endometriomas, adhesions, superficial peritoneal implants and extraperitoneal lesions, particularly those in the rectovaginal space and uterosacral ligaments as well as in solid endometriotic nodules. In view of longer imaging times required for MRI, antiperistaltic medication to decrease the bowel movement can minimize motion related artifact and also enhances the visualization of the bowel involvement.

The signal intensity of MRI depends on the contents of the endometrial implants. The contents of these implants mainly include the proteins and degraded blood products, the ratio of which varies according to the stage of the haemorrhage and thus the variation in the signal intensity can be noted on MR images. The acute haemorrhage may give hypointense (dark) signal on the T1 and T2 weighted images. In contrast the lesions containing degraded blood products like methemoglobin, proteins and iron may be seen as hyperintense (bright) on T1 (figure 3) and hypointense (dark) on T2 weighted images(figure 4). Multiple high signal lesions, usually in the ovaries, on T1-weighted images, also are highly suggestive of endometriosis. The diagnostic MR imaging features of endometrioma include cystic mass with high signal intensity on T1-weighted images and loss of signal intensity on T2-weighted images. This phenomenon is referred to as "shading" as a result of high protein and iron concentration from recurrent hemorrhage in the endometrioma.

The advent of fat saturated T1 weighted technique has greatly enhanced the value of MRI in differentiating among endometriomas and lipid containing ovarian tumors like dermoid cysts. Use of contrast medium (Gadolinium) has not shown any advantage over plain MRI for the purpose but it may be useful when malignant lesion is suspected.

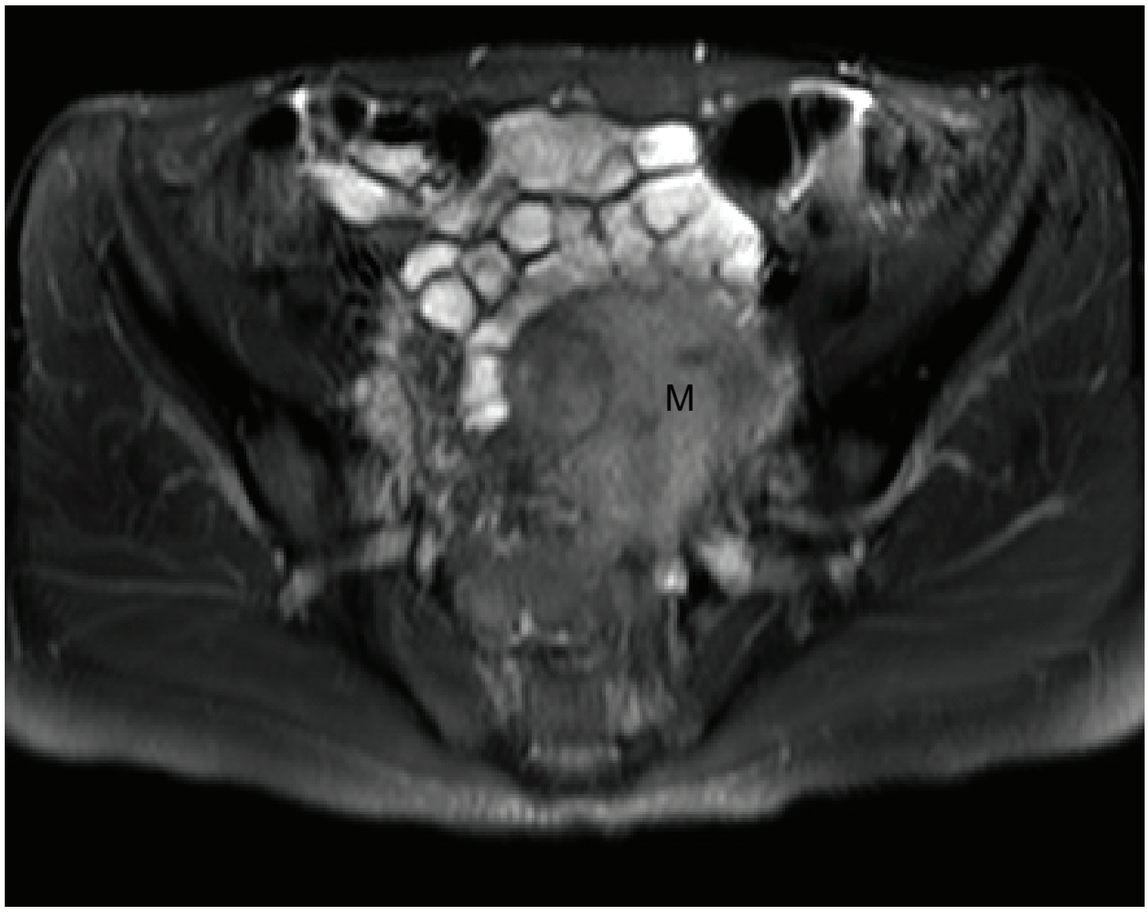

Fig. 3. Axial fat saturated T1Weighted image reveals T1 hyperintense lesions in the left ovary (M) suggestive a chocolate cyst/endrometrioma of the ovary.

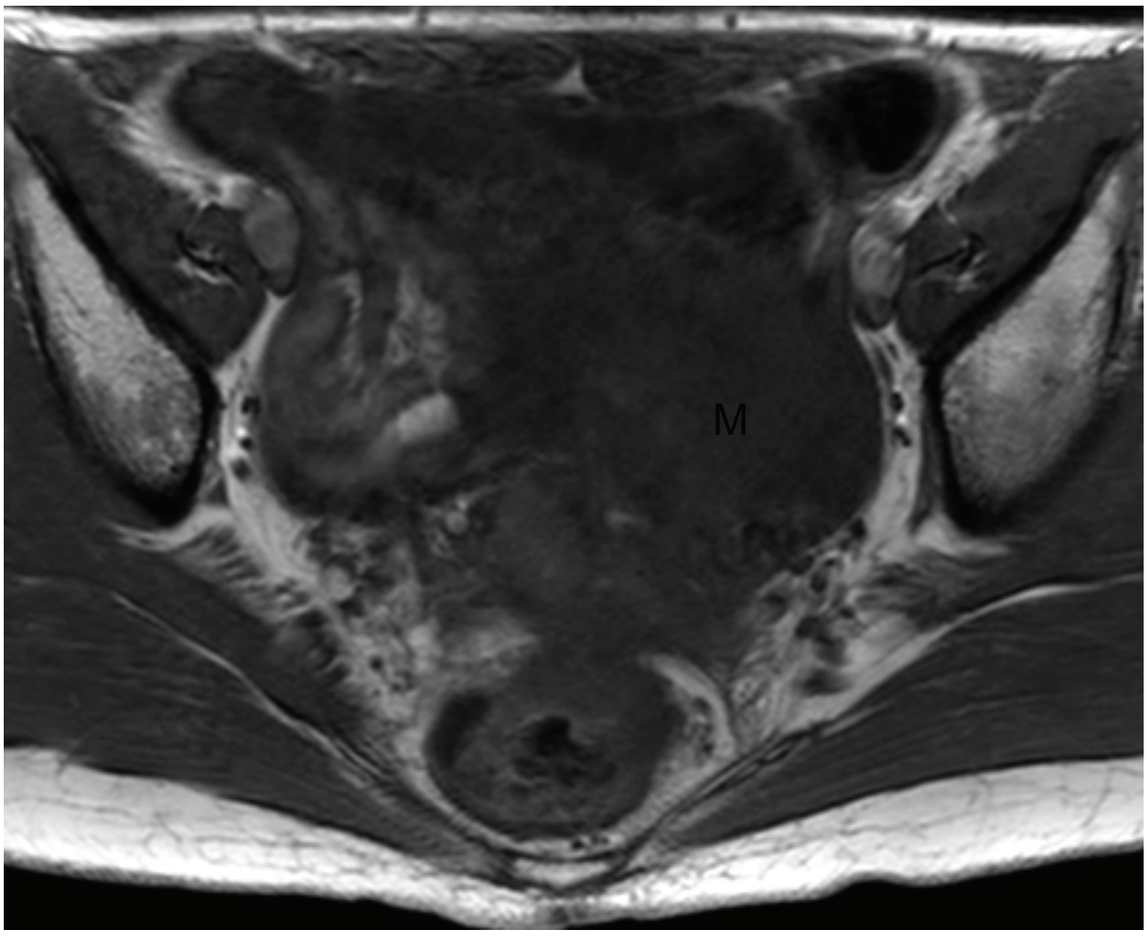

Fig. 4. Axial T2Weighted image showing the lesions are hypointense on T2W images.

The solid nodules of DIE appear as low intermediate signal on T1 weighted with punctuate areas of high signal and uniform low signals on T2 weighted images. The high signal zone is the consequence of foci of haemorrhage bounded by fibrous tissues. However it is difficult to identify superficial peritoneal implants on MRI.

Adhesions in the pelvis are one of the hallmarks of the disease. They appear as low signal areas of stranding. Adhesions are also suggested by the fixed retroverted uterus, angulated loops of bowel or displacement of the ovaries. Complications of endometriosis such as bowel implants and ureteral obstruction can often be detected on MRI.

It is now feasible to see the visceral deposits on MRI directly. Rather some studies claim MR imaging to be more specific than endorectal USG with sensitivity and specificity of 90-92% and 91 to 98% respectively (Gougoutas CA et al). MRI has valuable role in identification of nerve invasion (sciatic endometriosis) and abdominal wall lesions. The accuracy of MRI has been improved with the introduction of newer approach particularly endocavitary and phased array coils.

Role of MRI has been analyzed by various authors in the past. Stratton et al in a study reported 69% sensitivity and 75% specificity for detecting endometriosis confirmed on biopsy. MRI proposed diagnosis in nearly all patients with the severe form of the disease but by and large could recognize only small number of endometriotic areas as compared to surgery. Thus it is relatively less sensitive in determining the extent of the disease.

With this background in mind, the next section of the chapter will discuss in detail the features specific to different types of endometriosis on USG and MRI.

5. Different types of endometriosis

5.1 Superficial implants

Both USG and MRI has major limitation in diagnosing this type of endometriosis as already discussed. Endoscopy remains the standard practice to determine the extent of involvement by such lesions.

5.2 Endometriomas

Transvaginal sonography (TVS) is universally most frequently used imaging tool for evaluation of endometriomas. USG features of chocolate cysts are diverse. The classical appearance is that of a cystic structure with diffuse low level internal echoes and echogenic wall foci. The cyst may be unilocular or multilocular. It may contain thin or thick septa. Sometimes there may be wall nodularity. Wall nodularity if present requires further investigation to rule out malignancy. Imaging alone cannot exclude malignant neoplasm.

It is interesting to note that out of 20% of the endometriomas exhibiting wall nodularity, 35% had hyperechogenic wall foci (Patel et al). Effort should be made to distinguish between wall nodularity and the hyperechogenic foci within the wall. The latter when present in lesion with low level echoes and no features of malignancy is indicative of endometrioma.

Differential diagnoses of chocolate cyst include haemorrhagic cyst, dermoid cyst and cystic neoplasms. Dermoid cyst usually exhibit either echogenic shadow due to its fat content or acoustic shadowing due to calcium which aids in the diagnosis. To differentiate between haemorrhagic cyst and chocolate cyst can be a difficult task. The haemorrhagic cyst usually displays high level internal echoes within a thin walled cyst which may advance with time and emerge as a more complex cyst. Formation of fibrin may imitate thin septa but these lesions usually resolve on follow up.

The accuracy of USG can be further improved by color Doppler flow studies. Blood flow in the endometrioma is through the regularly spaced vessels running in the hilar region and the pericystic space.

MRimaging is another tool for identifying endometriomas. Due to the cyclical bleeding endometriomas contain blood products at different age. They are seen as bright or hyperintense lesions on T1 weighted image. On T2 they appear more hypointense or dark with foci of hyperintensity, imparting it the classical appearance of ‘shading’. Shading is

effect of degenerated blood products present at different stage within the same cyst. It can range from subtle layering to a complete signal void (black).

Since both the haemorrhagic cysts and the chocolate cyst contain blood products, it can be difficult to distinguish between them except for the fact that hemorrhagic cysts do not display shading, are mostly unilocular and resolve on interval imaging. In contrast dermoid cysts are easily diagnosed on MRI since they lose the signals and become dark on fat suppressed sequences.

After contrast administration, the periovarian peritoneal surface of the cyst can be enhanced which can help in identification of torsion ovary. Endometrioma in an enlarged but poorly enhancing ovary with peripherally located follicles is suggestive of torsion ovary on MRimaging.

5.3 Solid deep lesions

Solid deep lesions display low to intermediate signal intensity with punctuate areas of high signal intensity on T1 weighted images. Uniform low signal intensity is seen on T2 weighted images. The punctuate foci of high intensity are due to the zone of haemorrhage surrounded by abundant solid fibrous tissues. These may actually mimic metastatic lesions arising from intraperitoneal malignancies such as ovarian carcinomas. The two entities can be differentiated on T2 weighted images by the low signal intensity imparted by solid endometriomas often in combination with the presence of endometrial cyst.

Masses situated in the pouch of Douglas, posterior vaginal fornix and uterosacral ligaments may comprise of large fraction of glandular material with little fibrotic reaction, imparting hyperintense signals on T2 weighted images. Administration of contrast material will enhance such solid lesions, making it possible to distinguish it from necrosis or intramural hemorrhage.

Frequently the signal intensity may not be able to pick up the deep endometriosis of the uterosacral ligaments, especially if the punctuate foci of haemorrhage are missing in the lesion. In such case, the diagnosis is often made by correlating the thickening of the ligaments. Thickening more than 9mm in size or nodularity within the ligaments either bilateral or asymmetrical often give clue to the diagnosis.

5.4 Bladder endometriosis

Bladder endometriosis can be identified on MRI by deviation in signal intensity and gross anatomical anomalies in bladder wall thickness which can be localized or diffuse. Most of the times there are foci of high signal intensity in abnormally thickened bladder wall. Such findings may exist even if patients have normal cystoscopy result or without urinary symptoms. Bladder endometriosis infact infrequently infilterates the mucosa. Thus it is difficult to make out the lesions on cystoscopy. Advanced disease may present as ureteral obstruction and hydronephrosis.

5.5 Rectal endometriosis

Deep rectal involvement is less obvious on MRimaging due to the rectal contents which impart artifacts. Conventional MRI has infact sensitivity of only 33%. Results can be

improved with the use of phased array coils, endovaginal coils and rectal contrast enema. MRI features that can be helpful in diagnosis include thickening of the rectal wall correlated with specific symptoms clinically, low signal intensity on T2 weighted images, and occasionally the presence of punctuate hyperintense foci of haemorrhage.

Endorectal sonography as dicussed earlier is superior to MR imaging for diagnosis of this entity. The deposits on bowel are seen as rounded hypoechoic areas.

5.6 Malignant transformation in endometriosis

Malignant transformation in endometrioma is a rare well-known complication of endometriosis, occurring in a younger age group with estimated incidence is less than 1% of women with ovarian endometriosis. The common histologic types are endometrioid adenocarcinoma and clear cell carcinoma arising from glandular elements and rare form is endometrial stromal sarcoma occurs arising from stromal elements. Loss of the T2 shading effect is more commonly detected in malignant than in benign endometriomas. The postulated reasoning for this is dilution of haemorrhagic fluid by tumor secretions, although is not specific to malignant endometrial cysts. Enhancing mural nodules within a cystic mass is another feature of malignant change in endometriosis. Typically mural nodules are enhancing, T1-weighted low and variable T2-weighted signal intensities. Dynamic subtraction images with a gradient- echo sequence often improve nodule enhancement. Again, enhancing mural nodules within endometriotic cysts, although seen more commonly in malignant endometriomas is not specific and has been reported in benign lesions.

5.7 Scar endometriosis

Solid endometriosis can also develop in a caesarian section scar. MRI is valuable in identifying these lesions. MRI characteristically shows high signal intensity on T1 and hypointensity on T2 weighted images. Fat saturated sequences are more helpful in the diagnosis specially in context of myometrium along the surgical scar.

6. Conclusion

The imaging techniques have revolutionized the pre operative diagnosis of endometriosis although the ultimate confirmation is by histopathology only. The major advantage of these tools is being non invasive method.

7. References

Gougoutas CA, Siegelman ES, Hunt J, et al. Pelvic endometriosis: various manifestations and MR imaging findings. AJR Am J Roentgenol2000; 175: 353-358.

Knonickx PR, Meulman C, Demeyere S, Lesaffre E, CornillieFJ. Suggestive evidence that pelvic endometriosis is a progressive disease, whereas deeply infiltrating endometriosis is associated with pelvic pain. Fertil Steril 1991; 55: 759-765.

Patel MD, Feldstein VA, Chen DC, Lipson SD et al. Endometriomas: diagnostic performance of US. Radiology 1999; 210: 739-745.

Stratton P, Winkel C, Premkumar A et al. Diagnostic accuracy of laparoscopy, magnetic resonance imaging, and histopathologic examimation for the detection of endometriosis. Fertil Steril 2003; 79: 1078-1085

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This book provides an insight into the emerging trends in pathogenesis, diagnosis and management of endometriosis. Key features of the book include overviews of endometriosis; endometrial angiogenesis, stem cells involvement, immunological and hormonal aspects related to the disease pathogenesis; recent research reports on infertility, endometrial receptivity, ovarian cancer and altered gene expression associated with endometriosis; various predictive markers, and imaging modalities including MRI and ultrasound for efficient diagnosis; as well as current non-hormonal and hormonal treatment strategies This book is expected to be a valuable resource for clinicians, scientists and students who would like to have an improved understanding of endometriosis and also appreciate recent research trends associated with this disease.

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