Imaging diagnosis of adenomyosis

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Abstract

Adenomyosis is a benign common gynaecological disorder whose pre-operative diagnosis has previously been elusive. The accuracy of clinical diagnosis is low as the symptoms are non-specific. The advent of high resolution imaging techniques has made an accurate non-invasive diagnosis of adenomyosis possible. Adenomyosis may also co-exist with other pathology. The histopathologic features are varied and contribute to its imaging appearances. An understanding of these features is crucial in the interpretation of the imaging findings. This review focuses on the role of the non-invasive techniques available, their accuracy and the imaging features useful in the diagnosis of adenomyosis on the various modalities. Transvaginal ultrasound (TVS) and magnetic resonance imaging (MRI) have emerged as the imaging modalities of choice in evaluating women with suspected adenomyosis. TVS is useful as the initial imaging modality with MRI reserved for cases that are indeterminate at TVS or those with co-existing pathology.

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1. Background

Adenomyosis is a benign, common gynaecological condition causing heavy, painful periods in women of childbearing age who are often multiparous, though it may be found in nulliparous women. It was first described in 1860 by Rokitansky, and then clearly defined by Von Recklinghausen in 1896. It is characterised by the presence of heterotopic endometrial glands and stroma in the myometrium [1,2]. It is often associated with hypertrophy and hyperplasia of the myometrium surrounding the ectopic endometrial tissue [2]. The clinical diagnosis of adenomyosis is difficult and often inaccurate. This is due to the non-specific nature of the symptoms, which can also be encountered in conditions such as uterine fibroids, dysfunctional uterine bleeding and endometriosis. Previously, a conclusive diagnosis of adenomyosis could only be made by histology following a hysterectomy, but with the advent of modern imaging techniques, a pre-hysterectomy diagnosis can now be achieved with a high degree of accuracy.

Imaging has a three-fold role in assessing patients with a clinical suspicion of adenomyosis. Firstly, to establish the diagnosis and differentiate adenomyosis from other conditions such as leiomyomas which may be present in a similar fashion. This enables the correct management decisions to be made. Secondly, the extent or severity of the disease can be assessed as symptoms have been shown to correlate with disease extent. Thirdly, imaging can be used in disease monitoring in patients on conservative treatment [1].

2. Pathology

The histopathologic features are varied and contribute to its imaging appearance. An understanding of this fact is crucial in interpreting the imaging findings. Grossly, the uterus is often enlarged and globular and/or asymmetric. Histopathologically, ectopic endometrial tissue is found at least 2.5 mm beyond the endometrial/myometrial junction. These foci are associated with hyperplasia of the surrounding smooth muscle.
3. Imaging

Various imaging modalities have been used in the assessment of patients with suspected adenomyosis. These include hysterosalpingography (HSG), transabdominal ultrasound (TAS), transvaginal ultrasound (TVS), and most recently, magnetic resonance imaging (MRI).

3.1. Hysterosalpingography

Historically, HSG has been used in assessing women with suspected adenomyosis with occasional characteristic findings [3]. The most characteristic feature has been described as ill-defined areas of contrast intravasation, which extend from the uterine cavity into the myometrium in a perpendicular fashion [4]. Another study suggested that adenomyosis might account for 24% of cavities observed at hysteroscopy. These authors also felt that the cavities are usually not more than 5 mm in diameter and are often located in the upper half of the uterine cavity [5]. The general consensus however is that the sensitivity of this technique is too low for clinical practice, but awareness of the significance of these features is useful when seen on an examination carried out for other reasons.

3.2. Ultrasound

Both transabdominal and transvaginal ultrasound have been evaluated in the assessment of adenomyosis by various studies [1,2,6–8]. The sensitivity and specificity values reported vary widely and this may partly be explained by the differences in technique and criteria used in the studies as well as the prevalence rates of the populations in the studies.

The diagnostic criteria by TAS used in the different studies include an enlarged globular, regular uterus with no fibroids, myometrial cystic areas and a decreased myometrial echogenicity. Bazot et al. in 2001 reported a specificity and sensitivity of 95 and 32.5% and accuracy of 74.1% with TAS for the diagnosis of adenomyosis [7]. Siedler et al. in 1987 reported specificity and sensitivity values of 97 and 63% in a retrospective study of TAS for the diagnosis of adenomyosis [9]. The general consensus however is that TAS alone has a limited diagnostic capacity for adenomyosis especially in women with co-existing fibroids [2,10].

TAS is often performed in association with TVS, which results in a better diagnostic performance. The diagnostic criteria on TVS for adenomyosis have been described in previous studies as follows: distorted/heterogeneous myometrial texture, indistinctly demarcated or poorly defined area of abnormal myometrial echotexture, myometrial linear striations and myometrial cysts [1,2,7,11] (Fig. 1(a–c)).

Bazot et al. [7] reported a sensitivity of 65%, a specificity of 97.5% and an accuracy rate of 86.6% with TVS in diagnosing adenomyosis. They suggested that the most sensitive and specific criterion for adenomyosis was the presence of myometrial cysts [7]. Vercellini et al. reported sensitivity and specificity values of 82.7 and 67.1%, respectively, in a prospective study assessing the reliability of TVS and uterine needle biopsy used singly or in combination in the diagnosis of adenomyosis [11].

Atri et al. [12] evaluated the accuracy of the ultrasonographic features of adenomyosis in correlation with histology on 102 hysterectomy specimens. They reported sensitivity and specificity values of 81 and 71%, respectively, with an accuracy of 74%. They concluded that the presence of subendometrial linear striations, echogenic
nODULES OR ASYMMETRIC MYOMETRICAL THICKNESS IMPROVED THE SPECIFICITY OF US IN DIAGNOSING ADENOMYOSIS. THEY FOUND THAT A HETEROGENEOUS MYOMETRICAL ECHO TEXTURE WAS ONLY OF BORDERLINE SIGNIFICANCE [12]. MANY OF THE STUDIES REPORTED LIMITATIONS IN THE DIAGNOSTIC CAPABILITY OF BOTH TAS AND TVS IN THE PRESENCE OF CO-EXISTING FIBROIDS HOWEVER.

COLOUR DOPPLER SONOGRAPHY HAS ALSO BEEN EVALUATED IN DIFFERENTIATING ADENOMYOSIS FROM FIBROIDS. CHIANG ET AL. PROSPECTIVELY STUDIED 78 PATIENTS WITH SUSPECTED ADENOMYOSIS. THEY DEMONSTRATED THAT ADENOMYTIC LESIONS HAD RANDOMLY SCATTERED VESSELS OR INTRATUMORAL SIGNALS WHILE LEIOMYOMAS USUALLY HAD PERIPHERAL SCATTERED OR OUTER FEEDING VESSELS.

THE ULTRASOUND APPEARANCES ARE DIRECTLY RELATED TO THE CHANGES IDENTIFIED ON HISTOPATHOLOGICAL ANALYSIS. THE AREAS OF DECREASED ECHOCENICITY CORRESPOND TO AREAS OF SMOOTH MUSCLE HYPERPLASIA SEEN ON HISTOLOGY. THE HETEROGENEOUS AREAS CORRESPOND TO THE ECHOGENIC ISLANDS OF ECTOTIC ENDOMETRIUM SURROUNDED BY HYPECHOIC SMOOTH MUSCLE. THE MYOMETRICAL CYSTS ARE A RESULT OF DILATED CYSTIC GLANDS OR HAEMORRHAGIC FOCI WITHIN THE ECTOTIC ENDOMETRIAL TISSUE. THE LINEAR STRIATIONS ARE A RESULT OF EXTENSION OF THE HETEROTOPIC ENDOMETRIUM INTO THE INNER MYOMETRIUM [1].

3.3. Magnetic resonance imaging


Numerous studies have described the characteristic MRI appearances and evaluated the diagnostic capability of MR in the assessment of patients with adenomyosis as well as the optimal sequences useful in such assessment.

In 1988, Togashi et al. studied the MRI characteristics of adenomyosis in eight women who underwent hysterectomy, conducting a detailed radiologic/pathologic correlation. They described the adenomyotic foci as diffuse low signal intensity areas with tiny high signal intensity spots subjacent to the endometrium. These areas were isointense with the junctional zone (JZ) and appeared as focal or diffuse thickening of the junctional zone. Histology confirmed the low intensity areas as the adenomyotic areas and the high intensity spots as both haemorrhagic and non-bleeding endometrial tissue [14] (Fig. 2(a and b); Fig. 3(a and b)). A prospective study of 119 patients (28 of whom had histologically proven adenomyosis) by Reinhold et al. found a significant difference in mean junctional zone thickness between the two patient groups (with and without disease) and suggested an optimal junctional zone thickness value of ≥12 mm [6]. Bazot et al. in 2001 found that the most specific MRI criteria were high signal intensity myometrial spots, thickened junctional zone >12 mm, junctional zone: myometrial thickness ratio >40% [7] (Fig. 4).

The junctional zone thickness value specific for the diagnosis of adenomyosis has been debated and evaluated by various studies. Previously, a value as low as 5 mm was
suggested as being the upper limit of normal with any value above this said to be indicative of adenomyosis [15,16]. However, in 1996, Kang et al. prospectively investigated the specificity of this criterion (5 mm junctional zone thickness as upper limit of normal). Their data suggested that a maximal junctional zone thickness of 8 mm could easily be normal when no other findings such as high intensity foci are seen to support a diagnosis of adenomyosis [17]. This finding has been confirmed by later studies suggesting a junctional zone thickness of ≥12 mm for the diagnosis of adenomyosis [6,7].

Bazot et al. in 2001 also showed that using the ratio of the maximal junctional zone thickness to the corresponding overall myometrial thickness with a value of >40% was 65% sensitive and 92.5% specific with an accuracy of 83.3% in diagnosing adenomyosis [7]. Dueholm et al. in their study suggested that the diagnostic accuracy at MRI could be improved by calculating the maximum difference between the thinnest and thickest portions of the junctional zone with a value of ≥5–7 mm [18]. On the T2-weighted images, diffuse adenomyosis is seen as a thickening of the junctional zone whereas focal adenomyosis appears as a hypo-intense mass poorly delineated from the surrounding myometrium [17].

Various sequences have been assessed in the evaluation of the female pelvis. It is recognised that the uterus is optimally depicted using a T2-weighted sagittal sequence. This best depicts the uterine zonal anatomy. The standard sequence is a T2-weighted fast spin echo (SE) sequence, but other sequences have been assessed in an attempt to optimise image quality and lesion conspicuity.

Krinsky et al. in 1997 compared three rapid T2-weighted pulse sequences with the standard T2 turbo spin echo sequence. They found that the three sequences, half-Fourier single shot turbo SE (HASTE), turbo GRASE (TGSE) and breath-hold turbo SE, provided equivalent diagnostic
information when compared with the standard high-resolution turbo SE images [19]. The breath-hold turbo SE (BH T2FSE) sequence has also been evaluated by other authors with similar results and they suggest that it may be possible to replace the standard T2FSE sequence with the BH T2FSE sequence for some uterine applications [20]. Contrast enhanced T1-weighted images have not been shown to improve the diagnostic yield for adenomyosis [7,21,22].

Several studies have demonstrated a high accuracy of MRI for diagnosing adenomyosis with a sensitivity and specificity ranging from 86 to 100% [6,14–16,21]. This is particularly so in the symptomatic patient.

4. Diagnostic pitfalls

The commonest differential diagnosis of adenomyosis is leiomyomas. They both have a similar clinical presentation and often co-exist. There is also some overlap in the imaging appearances. Their differentiation is critical for these reasons as well as the different therapeutic options.

At imaging, leiomyomas generally tend to have clearly defined margins, a mass effect, globular shape and peripheral/marginal vessels. At TVS, they may be calcified, have a whorled appearance with edge shadowing and lack the diffuse linear striations of adenomyosis [10]. At MRI,
leiomyomas lack the hyperintense linear striations, which are specific for adenomyosis. They are also not related to diffuse thickening of the junctional zone (Fig. 5). They may however be indistinguishable from adenomyomas, which are better circumscribed than the diffuse form and may exhibit a mass effect.

Myometrial contractions may appear similar to focal adenomyosis with a focal thickening of the junctional zone. These are however transient and change over time. Some studies have advocated the use of dynamic scans to assess the myometrial contractility [23].

Adenomyosis may co-exist with endometrial carcinoma giving rise to staging errors. It may also mimic carcinoma at imaging.

5. MRI versus ultrasound

Numerous studies have compared the accuracy of MRI and ultrasound scanning in the diagnosis of adenomyosis [1,6,7,15,16,18]. The earlier studies suggested MRI had higher accuracy than TVS while the later studies reported similar accuracy figures. It is felt that the discrepancy may be explained by the technological improvements in ultrasonography as well as the study population.

TVS has several advantages over MRI. It is widely available, relatively inexpensive compared to MRI. It is well tolerated by most patients and generates high quality images not limited by patient size or uterine position. However, it has its limitations. It is operator-dependent and may not be reproducible in patients on follow-up. The presence of intramural fibroids can hinder assessment of the adjacent myometrium.

MRI, on the other hand, is less operator-dependent. Some authors recently suggested that the accuracy for the diagnosis of adenomyosis is highly influenced by the radiologist’s experience in MR imaging of the female pelvis [24]. The images are standard and reproducible. The presence of fibroids does not affect the diagnostic accuracy of MRI as it does in TVS. MRI is less widely available, however, it is not suitable for all patients and is more expensive.

6. Conclusion

The non-invasive diagnosis of adenomyosis is no longer elusive with the advent of high resolution imaging techniques such as TVS and MRI. Both have been demonstrated to have similar levels of accuracy and each have a role in the evaluation of women suspected to have adenomyosis. TVS is useful as an initial imaging tool while MRI can be reserved for indeterminate cases on TVS and for monitoring patients on hormonal treatment. It is imperative that sonographers are familiar with the ultrasound features of adenomyosis as it presents in a similar fashion to many other gynaecological conditions. Radiologists reporting on MRI of the female pelvis also need to be aware of the MRI features of adenomyosis and the potential pitfalls.

Practice points:

- Imaging diagnosis of adenomyosis is now feasible.
- Transvaginal ultrasound is useful as a screening tool in most patients.
- TVS is of limited value in patients with co-existing fibroids.
- MRI has a higher diagnostic capability especially in the presence of fibroids.
- Interpretation of the studies requires a high index of suspicion, familiarity with the imaging features of adenomyosis and the potential pitfalls.

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References