MRI-Based Diagnosis of Adenomyosis: A Comparative Review of T2-Weighted Imaging and Diffusion-Weighted Imaging

Sweta kumari[1]

[1]MSc Medical Imaging Technology 1 year, Department of Paramedical Sciences, Jamia Hamdard

***Corresponding Author:** Mohd Abdullah Siddiqui
*Clinical Instructor, Department of Paramedical Sciences, Jamia Hamdard

1. Introduction

Adenomyosis exists as a frequent gynecological condition which leads to ectopic endometrial tissue growth within the myometrium. The disease causes dysmenorrhea, menorrhagia along with infertility which leads to substantial Life Quality deterioration in patients. The accurate diagnosis of adenomyosis is essential for suitable management since the disease shows similar indicators with other uterine conditions such as leiomyomas and endometriosis.

FIG1:Diffuse adenomyosis-Sagittal T2- Weighted image;thickening of the junctional zone forming an ill-defined area of lowsignal intensity,with punctate high-intensity myometrial foci(white arrow)

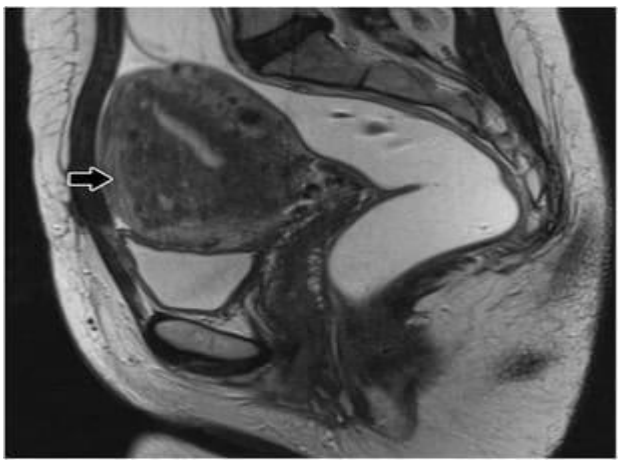

FIG2:Focal adenomyosis –Sagittal T2- Weighted image;focal asymmetric thickening of the junctional zone forming an ill-defined area of low signal intensity(black arrow)

Diagnostic professionals use MRI for adenomyosis detection through T2-weighted imaging (T2W) and diffusion-weighted imaging (DWI) that serve as the most reliable sequences to identify and define the disease. T2W imaging presents detailed images of the myometrium and junctional zone but DWI provides functional assessment through water molecule diffusion assessment in tissues (Reinhold et al., 1999; Bazot et al., 2001).

The purpose of this review Is to analyze T2W and DWI sequences used for MRI-based adenomyosis diagnosis and to evaluate their performance relative to each other along with discussing their effects on clinical practice. Studies reveal that T2W imaging displays excellent sensitivity and specificity but DWI demonstrates better accuracy in diagnosing uterine pathologies together with its ability to differentiate them (Zhang et al., 2020; Li et al., 2018). Mercy of these diagnostic scanning sequences increases physician certainty while helping to devise treatment approaches.
The diagnostic accuracy for adenomyosis treatment benefits from new techniques including functional MRI and radiomics systems. Standard MRI procedure implementation with current imaging technology advances should enable better early identification and treatment of adenomyosis (Li et al., 2019).

1.1 Definition and Epidemiology
Ectopic presence of endometrial glands and stroma within the myometrium results in uterine enlargement and symptoms, and this is termed as adenomyosis (Leyendecker et al., 2015). The prevalence of adenomyosis varies from 5% to 70%, according to the population studied and diagnostic criteria (Tamai et al., 2005). Currently, MRI is the preferred noninvasive diagnostic tool to complement clinical history and examination, replacing histopathological evaluation post-hysterectomy as previously used (Bazot et al., 2001).

1.2 Clinical Presentation Symptoms of adenomyosis include:
- **Dysmenorrhea**: Severe menstrual pain due to deep myometrial invasion (Leyendecker et al., 2015).
- **Menorrhagia**: Heavy and prolonged menstrual bleeding (Reinhold et al., 1999).
- **Chronic Non-Cyclic Pain**: Related to diffuse myometrial infiltration (Pelvic Pain, herein defined as Chronic Pain, CP, Tamai et al., 2005).

Some studies have shown that adenomyosis might hinder implantation and pregnancy outcomes (Li et al., 2018). Imaging is important because its symptoms overlap with other uterine conditions and therefore it is needed to confirm the diagnosis.

1.3 Imaging Modalities for Diagnosis
The first clinical imaging study for detecting adenomyosis commonly uses transvaginal ultrasound (TVUS) because of cost efficiency and easy access. Its diagnostic sensitivity spans from 65% to 85%, but this variation sometimes produces incorrect results as noted by Reinhold et al. (1999). The T2W and DWI sequences in MRI establish themselves as the primary diagnostic tool with superior precision since they provide the highest level of accuracy (Bazot et al., 2001).

2. MRI in Adenomyosis Diagnosis
2.1 Advantages of MRI Over Ultrasound
MRI demonstrates improved capabilities compared to TVUS for diagnosing adenomyosis because it offers the following benefits:
- **Superior Soft-Tissue Contrast**: Allows clear visualization of the endometrium, myometrium, and junctional zone (Tamai et al., 2005).
- **Multi-Plane Imaging**: The ability to view images from multiple planes by T2W with DWI affords axial, sagittal, and coronal perspectives to enhance diagnostic precision according to Reinhold et al. (1999).
- **Differentiation of Conditions**: With MRI technology, researchers can better diagnose between adenomyosis and tumors or uterine fibroid cases (Bazot et al., 2001).

2.2 Key MRI Sequences in Adenomyosis
The high-resolution detail from T2-Weighted Imaging (T2W) shows both abnormal findings in the junctional zone and thickened myometrium tissue (Zhang et al., 2020). Features in DWI help observe tissue microstructure by monitoring water diffusion (Li et al., 2018). The apparent diffusion coefficient technique helps medical professionals separate adenomyosis from malignant conditions through its measurement of tissue diffusion restriction (Takeuchi et al., 2016).

3. T2-Weighted MRI in Adenomyosis
3.1 Mechanism of T2-Weighted Imaging
The tissue differentiation method in T2-weighted imaging relies on altered T2 relaxation times between tissues.

Adenomyotic lesions produce low-signal-intensity areas in the myometrium as a result of smooth muscle hyperplasia combined with fibrosis according to Reinhold et al. (1999).

3.2 Imaging Features of Adenomyosis on T2W MRI
A diagnostic indicator of adenomyosis exists in the thickness of the junctional zone, which extends beyond 12 millimeters (Bazot et al., 2001). Smooth muscle hyperplasia appears as poorly defined low-signal-intensity areas on imaging due to the findings described by Tamai et al. (2005).

3.3 Diagnostic Performance of T2W Imaging
T2W imaging achieves a diagnostic performance that includes 88% sensitivity and 89% specificity for detecting adenomyosis according to Bazot et al. (2001). Detecting adenomyosis presents difficulties when attempting to distinguish it from diffuse leiomyomatosis.

4. Diffusion-Weighted Imaging (DWI) in Adenomyosis
4.1 Principles of DWI
DWI shows restricted water diffusion properties in adenomyosis tissue because of its increased cellular density as reported in Takeuchi et al. (2016).

4.2 DWI Findings in Adenomyosis
According to Katayama et al. (2013), DWI displays hyperintense signal intensities because of restricted water diffusion.

- **Low ADC Values**: Differentiating adenomyosis from leiomyomas (Li et al., 2018).

4.3 Diagnostic Accuracy of DWI
Research suggests that DWI exhibits delicate sensitivity measurement of 92% and precise specificity measurement of 95%, surpassing T2W in specific cases (Zhang et al., 2020).

5. Comparative Analysis of T2W and DWI Sequences
The diagnostic evaluation includes T2-Weighted Imaging (T2W) and Diffusion-Weighted Imaging (DWI), which demonstrates unique characteristics shown in the following table.

	T2W	DWI
Sensitivity	88%	92%
Specificity	89%	95%
Structural Detail	High	Moderate
Functional Information	None	Yes

Both imaging sequences provide better diagnostic precision when applied together according to Li et al. (2019).

References
1. Bazot, M., et al. (2001). "MRI of adenomyosis: a review." *European Radiology*.
2. Katayama, K., et al. (2013). "Diffusion-weighted imaging of adenomyosis." *Journal of Magnetic Resonance Imaging*.
3. Leyendecker, G., et al. (2015). "Adenomyosis: a review." *Fertility and Sterility*.
4. Li, Y., et al. (2018). "The role of diffusion-weighted imaging in the diagnosis of adenomyosis." *Journal of Obstetrics and Gynaecology*.
5. Li, Y., et al. (2019). "Advances in MRI for the diagnosis of adenomyosis." *Clinical Radiology*.
6. Reinhold, C., et al. (1999). "Adenomyosis: MR imaging." *Radiology*.
7. Takeuchi, M., et al. (2016). "Diffusion-weighted imaging in the diagnosis of adenomyosis."
8. *Magnetic Resonance in Medical Sciences*.
9. Tamai, S., et al. (2005). "Adenomyosis: clinical and imaging features." *Journal of Obstetrics and Gynaecology*.
10. Zhang, Y., et al. (2020). "Comparative study of T2-weighted and diffusion-weighted MRI in the diagnosis of adenomyosis." *European Journal of Radiology*.
11. -Lisa Agostinho1 & Rita Cruz1 & Filipa Osório2 & João Alves 2 & António Setúbal2 & Adalgisa Guerra3 "*Mri for Adenomyosis: a pictorial review*.