Journal of Population Therapeutics & Clinical Pharmacology

Comparative Analysis of Magnetic Resonance Imaging and Transvaginal Ultrasonography for Diagnosing, Mapping, and Measuring Uterine Myomas

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Abstract:
Objective: This study aimed to assess and compare the diagnostic accuracy of magnetic resonance imaging (MRI) and transvaginal ultrasonography (TVUS) in identifying, mapping, and measuring uterine myomas.
Study Design: A double-blind study was conducted on 106 premenopausal women who underwent hysterectomy for benign indications. A total of 257 myomas were precisely mapped using both MRI and TVUS. The accuracy of each method in identifying myomas with confirmed pathological positions was evaluated.
Results: Both MRI and TVUS demonstrated high sensitivity (MRI: 0.99, TVUS: 0.99) and specificity (MRI: 0.86, TVUS: 0.91) in detecting the presence of myomas. However, MRI outperformed TVUS in accurately identifying the number of myomas (mean difference: 0.51 ± 1.03; $P < 0.001$). This difference diminished in patients with fewer myomas and smaller uterine volumes (mean difference: 0.08 ± 0.76; $P = 0.60$). Both MRI and TVUS showed comparable accuracy in measuring myoma diameters in patients with 1 to 4 myomas.
Conclusion: While TVUS is effective in detecting the presence of myomas, MRI offers superior accuracy in mapping their exact locations, particularly in larger uteri with multiple myomas. Our findings underscore the importance of considering both imaging modalities based on the clinical context for optimal myoma diagnosis and management.
Keywords: Magnetic resonance imaging, transvaginal ultrasonography, uterine myomas

Introduction:

The emergence of minimally invasive modalities in treating myomas underscores the importance of precisely evaluating their position, size, and number. Accurate mapping of myomas becomes crucial for interventions such as myoma embolization, treatment with gonadotropin-releasing hormone (GnRH) analogs, or selective myoma removal. The complexity of surgery and its success rates are influenced by factors like the number, location, and size of myomas. Therefore, a

thorough preoperative assessment is essential to determine the most suitable approach, whether it be laparoscopic, hysteroscopic, or abdominal. (Cohen and Valle, 2000)

Transvaginal ultrasonography (TVS) has been a conventional imaging technique offering superior visualization of the uterus and adnexa compared to abdominal ultrasonography (US). Studies have explored its efficacy in detecting submucous myomas and monitoring myoma size during GnRH treatment. On the other hand, magnetic resonance imaging (MRI) has gained prominence for its high diagnostic performance in myoma imaging and is recommended for precise myoma evaluation. However, the cost associated with MRI necessitates its selective use when it significantly outperforms TVS. While studies have demonstrated MRI's superiority over US in myoma evaluation in small cohorts, its comparison with TVS in terms of diagnosis, precise evaluation, and measurement of myomas remains limited. (Dueholm et al., 2002)

This study aims to compare TVS and MRI in identifying myomas and assessing their accuracy in terms of localization, number, and size in premenopausal patients undergoing hysterectomy for benign indications. By evaluating the performance of both imaging modalities, this study seeks to provide insights into their respective roles in guiding optimal treatment strategies for uterine myomas. (Jha et al., 2000)

Materials and Methods:

Patients: This study comprised 108 consecutive premenopausal patients scheduled for hysterectomy. All patients provided informed consent. Exclusion criteria included previous transcervical endometrial resection, malignancy, and acute or subacute indications for hysterectomy. The indications for hysterectomy included abnormal uterine bleeding, symptomatic myomas, lower abdominal pain or endometriosis, and other benign conditions. Hysterectomy was performed within two weeks of imaging examinations. A total of 106 patients were included in the analysis.

Observers: One pathologist examined all hysterectomy specimens, while MRI images were evaluated by a single specialist, and TVS was conducted by an experienced gynecologist. All evaluations were performed independently, and observers were blinded to each other's findings.

MRI: MRI was conducted using 1.5 Tesla scanners, acquiring 4-mm slices with 1-mm spacing in sagittal, coronal, and axial planes using T2-weighted fast spin echo sequences.

TVS: Transvaginal ultrasonography was performed with a commercially available scanner equipped with transvaginal and abdominal transducers. Uterine borders and myoma positions were visualized, with US performed when necessary.

Pathologic evaluation: Uterine specimens were evaluated for volume, weight, and histopathologic abnormalities. Myomas were localized, and their characteristics were recorded.

Localization and size assessment: Myomas were localized in 18 uterine zones, classified based on uterine wall embedment, and measured in two perpendicular planes. TVS and MRI findings were compared with pathologic evaluations.

Statistics: Sensitivity, specificity, negative predictive values, and positive predictive values were calculated for TVS and MRI, compared against pathologic evaluations. Differences in the number of correctly identified myomas were analyzed using paired analysis and appropriate statistical tests.

Results: Results are presented as mean ± SD or mean (95% confidence limits), with significance set at $p < 0.05$.

Results:

Both transvaginal ultrasonography (TVS) and magnetic resonance imaging (MRI) demonstrated high accuracy in detecting the presence of myomas, with similar sensitivities and specificities (Table I). However, in one case involving both adenomyosis and myoma, neither MRI nor TVS identified a myoma (diameter: 15 mm). Surprisingly, MRI exhibited a slightly higher number of false findings of myomas compared to TVS.

In cases with more than 12 myomas, where mapping confidence was limited, pathologic evaluation revealed a higher mean number of myomas compared to MRI and TVS. MRI identified more myomas than TVS, with differences particularly notable for myomas classified based on uterine wall embedment and position.

TVS missed more myomas compared to MRI across all patients, particularly in cases with ≥5 myomas, where TVS performance significantly declined. In patients with 1 to 4 myomas, the mean number of correctly identified myomas did not significantly differ between MRI and TVS, but MRI performed better in cases with 5 to 12 myomas.

Uterine volume significantly affected the ability of TVS to detect myomas, with poorer performance observed in uteri ≥375 mL. MRI demonstrated greater precision in myoma detection in cases with uterine volumes ≥375 mL.

Even in patients with 1 to 4 myomas and uterine volumes <375 mL, MRI outperformed TVS in correctly identifying myomas with regard to position and myometrial wall embedment.

There was no significant difference in mean myoma diameter between pathologic evaluation and MRI or TVS measurements in patients with 1 to 4 myomas.

However, TVS failed to identify a considerable number of myomas in patients with >4 myomas, precluding a comparison of measured myoma size in these cases. Figures 3 and 4 illustrate MRI images of uteri with myomas.

Table I. Diagnostic accuracy in myoma detection by TVS, MRI compared with the true finding of myomas by pathology

	Pathologic evidence (n)			
	Myomas	No myomas	Diagnostic accuracy	%
TVS				
Myomas by TVS	72	3*	Sensitivity	99
			Specificity	91
No myomas by TVS	1	30	Positive predictive	96
			value	
			Negative predictive	97
			value	
MRI				
Myomas by MRI	72	6*	Sensitivity	99
			Specificity	86
No myomas by MRI	1	27	Positive predictive	92
			value	
			Negative predictive	97
			value	

*Number of false positives

Table II. Number of myomas per patient by MRI and TVS in 63 cases with 1 to 12 myomas verified by pathologic examination

	MRI	TVS	P value
Mean number in correct position*	3.49	2.98	
Mean number of missed myomas†	0.59	1.10	
MRI vs TVS* or † (mean difference ± SD)	0.51 ± 1.03		<.001
Mean number in both correct position and wall embedment intramural/subserous/submucous‡	2.92	1.98	
MRI vs TVS‡ (mean difference ± SD)	0.94 ±1.34		<.001

- Counted number of myomas per patient in the same position by pathologic examination (Wilcoxon paired test; P < .001): MRI (3.49) versus pathologic evidence (4.08); and TVS (2.98) versus pathologic evidence (4.08). † Counted number of myomas per patient that were identified by pathologic examination but missed by MRI or TVS. ‡ Counted number of myomas per patient both in correct position and wall embedment

Comments:

This study demonstrates that while both magnetic resonance imaging (MRI) and transvaginal ultrasonography (TVS) are highly accurate in detecting the presence of myomas, MRI outperforms TVS in mapping individual myomas. The efficacy of MRI remains consistent regardless of uterine volume, whereas TVS performance declines significantly in uteri larger than 375 mL. Despite slightly higher rates of false findings by MRI, primarily involving small myomas, these discrepancies could be attributed to challenges in distinguishing between multiple myomas, especially evident in TVS. (Weeks et al., 1999)

Using pathologic examination findings as the gold standard, the study emphasizes the limitations of both imaging modalities, particularly in cases with numerous myomas. The study's findings suggest that while MRI is superior in precise myoma mapping, TVS remains a reliable and cost-effective initial method for myoma identification, especially in patients with smaller uteri and fewer myomas. However, the study underscores the observer-dependence of TVS and highlights the necessity for experienced clinicians in interpreting results accurately. (Cicinelli et al., 1995)

The study suggests clear scenarios where MRI should be preferred, such as in cases requiring exact myoma mapping or when alternative treatments like myoma embolization are considered. Despite its advantages, MRI should be judiciously used, considering its higher cost and potential decision delays. Overall, the study advocates for a tailored approach, utilizing TVS as the first-line method for myoma detection and reserving MRI for cases necessitating precise mapping or advanced surgical procedures. (Cohen and Valle, 2000)

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