International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2023; 6(3): 17-21
Received: 16-04-2023
Accepted: 21-05-2023

Dr. Sachin Khanduri
Professor and HOD, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Vaibhav Pathak
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Surbhi
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Ashkrit Gupta
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Sachin Goswami
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Kunal Dwari
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Vinima Jaiswal
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Dr. Somya Singhal
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Corresponding Author:
Dr. Ashkrit Gupta
M.B.B.S, MD Radiodiagnosis, Era's Lucknow Medical College, Lucknow, Uttar Pradesh, India

Reliable diagnosis of adenomyosis and uterine fibroids using transvaginal ultrasonography with strain elastography

Dr. Sachin Khanduri, Dr. Vaibhav Pathak, Dr. Surbhi, Dr. Ashkrit Gupta, Dr. Sachin Goswami, Dr. Kunal Dwari, Dr. Vinima Jaiswal and Dr. Somya Singhal

DOI: https://doi.org/10.33545/26644436.2023.v6.i3a.338

Abstract
Introduction: Special types of benign gynecological conditions such as uterine fibroids and adenomyosis are very common these days. So our main objective is to assess the diagnostic accuracy of transvaginal ultrasonography combined with strain-ratio elastography (SRE) in diagnosing Adenomyosis and Uterine Fibroids and to compare the results with magnetic resonance imaging (MRI)-based diagnoses.
Material and Methods: In a prospective study was conducted on 84 women with suspected adenomyosis or fibroid on transabdomisnal sonography. These patients underwent transvaginal ultrasonography combined with strain-ratio elastography. This was followed by MRI imaging of the same patients. Computation of strain values at two ROIs placed next toeach other in a uterine adenomyosis or fibroid (ROI A) and the normal myometrium (ROI B). The strain ratio (B/A) was calculated and stored. These elastography based diagnoses were compared with MRI diagnoses.
Results: The myometrium was uniform in color, with a main color of green, indicating stiffer tissue. Adenomyosis and fibroids had dissimilar attributes with respect to elastographic and color patterns. In general, fibroids were darker blue and adenomyosis was yellowish to red in color. The median strain ratio was significantly (p<0.001) different between the uterine fibroid and adenomyosis. Median strain ratio were 1.85 and 0.54 for fibroids and adenomyosis respectively. The diagnosis of adenomyosis and fibroids using elastography shows harmonious results with MRI-based diagnosis.
Conclusions: The chromic data makes it possible for detecting uterine fibroid and adenomyosis and assists to detect both focal findings, in addition, the strain ratio allows for quantification of the stiffness factor. The quantitative data from the strain ratio is more useful than the qualitative color-coded images. Elastography is capable of recognizing discerning attributes of fibroids and adenomyosis. Elastography based conclusions are in excellent agreement with that of MRI. With easier and cheaper availability of the sonographic setup and reduced scanning time as compared to MRI, transvaginal ultrasonography in conjugation with strain ratio can be used to make a reliable diagnosis of fibroid or adenomyosis.

Keywords: Uterine fibroids, adenomyosis, transvaginal ultrasound, elastography, magnetic resonance imaging

Introduction

Benign uterine diseases are most prevalent gynecological conditions affecting women and commonly during child-bearing age [1]. These include uterine fibroids (UFs) and adenomyosis (AM), which are major causes of dysfunctional uterine bleeding [2].

UFs, commonly known as uterine leiomyoma, are among the most common benign uterine tumours in women, which often cause dysmenorrhea, pelvic pain, menorrhagia, and infertility and are sometimes completely asymptomatic [3]. UFs represent one of the major indications for hysterectomy [2, 3].

AM is due to hypertrophy of the endometrial glands causing abnormal growth of endometrial tissue within the myometrium leading to an inflamed and bulky uterus. Major symptoms include chronic pelvic pain, dysmenorrhea and menorrhagia, or may be completely asymptomatic [4].

The prevalence of adenomyosis is reported to be up to 75% [5].

Both pathologies can cause substantial morbidity. Uterine fibroids and adenomyosis may require medical treatment or surgery. Therefore, there is considerable interest in improving their diagnosis and achieving detailed information about their exact location and extent, especially with regard to an upcoming surgical intervention [6]. Their differential diagnosis still represents a challenge.

Due to availability, patient tolerance, low cost and relative accuracy transvaginal ultrasound (TVUS) is currently an initial diagnostic tool [7]. Elastography is an ultrasound tool that delivers information about the elasticity of tissue, addition of elastography to transvaginal ultrasound (TVUS) can be helpful for a more accurate imagistic recognition. Elastography can be split into two main systems: strain ratio elastography (SRE) and shear wave elastography (SWE) [8]. SRE is a qualitative method that involves the application of repetitive minimal pressure by the examinator on an anatomical structure, which provides information about region of interest (ROI) stiffness in comparison with the surrounding tissue [9]. SWE instead is a quantitative tool that imparts an approximate stiffness of the tissue expressed in kPa of ROI [10]. TVUS combined with elastography may turn out to be an important technique in differential diagnosis of uterine pathologies.

Magnetic resonance imaging (MRI) is also a precise modality for diagnosing fibroids and adenomyosis and may be more helpful than TVS in comparison between adenomyosis and fibroid [11]. MR imaging is also an accurate, non-invasive modality for diagnosing adenomyosis with a high sensitivity (78%-88%) and specificity (67%-93%) [12].

The aim of this study is to assess the diagnostic accuracy of transvaginal ultrasonography combined with strain-ratio elastography (SRE) in diagnosing Adenomyosis and Uterine Fibroids and to compare the results with magnetic resonance imaging (MRI)-based diagnoses.

Materials and Methods

This prospective study was conducted in the Department of Radiodiagnosis in Era's Lucknow Medical college and Hospital for 18 months on 84 patients. The approval from ethical committee was obtained by letter no EC/2021/132.

Sample size was calculated on the basis of specification and Positive Predictive Value of use using the formula:

$N = Z\alpha 2 \times P(1-P) / C2$

Where, Zα=1.96 (95% CI), P=Prevalence=5% (on the basis of Tertiary Care Hospital- Era's Lucknow Medical College and Hospital) and C=Margin of error=5%

Sample Size = 22×0.05×(1-0.05) /(0.05)2

= 4×0.05×0.95 = 76 0.0025

Loss=10%=8 Then sample size came out to be=84

Study females include patients of age group 20- 46 years showing uterine pathology on abdominal ultrasound who signed written consent to participate in the study and were willing for a transvaginal ultrasound examination. Excluded females include those who were not willing to undergo transvaginal ultrasound examination, unmarried females, and those with concomitant lesions.

2D Trans-Vaginal ultrasonography with Strain-Ratio Elastography were performed on the study group population and the control group population. A single radiologist evaluated the imaging studies in order to minimize the inter-observer bias. For ultrasound examination and strain ratio elastography, we used a single machine 'Samsung HS 70A, Samsung Medison, Korea' using 'VR5-9Hz' probe to reduce the variation in observation due to the use of multiple machines.

2D Trans-Vaginal ultrasonography and strain ratio elastography was performed in real-time on the uterus.

In the elasto-sonographic images, the vaginal probe was used to provide external pressure, through which deformation and compression of the targeted tissue were ensured, obtaining a strain ratio value. The pressure was wielded by the examiner in agreement with the quality indicator of the ultrasound machine, thereby denoting the degree of pressure needed to gain the maximum quality of the images. Thus, using this index as a reference, we were able to obtain reproducible values in iterative measurements. We carried out three cycles of gentle compression and relaxation. The encoding of the image obtained was indexed using 4 colors, namely red, yellow, green and blue. Therefore, both red and yellow colors were representative of soft tissue, blue denotes rigid tissue, green color indicated intermediate stiffness tissue. The adjacent endometrial tissue was used to compare the stiffness of the study tissue. Thus, the strain ratio and color map denote the rigidity of the studied tissues. The ROI [B] depicts reference tissue (the adjacent endometrium) and the ROI [A] depicts the studied tissue. The strain ratio [B/A] was calculated for the lesion and the recorded data stored for evaluation.

These patients then underwent an MRI examination on 3 Tesla 'MAGNETOM Vida. Siemens Healthcare, Germany'. On MRI, adenomyosis appears as an ill-defined area of low signal intensity, occasionally with embedded bright foci on T2-weighted image presenting as either focal or diffuse thickening of the junctional zone. Fibroids on MRI appear as well-defined, rounded, heterogeneous intensity lesions causing mass effect on the endometrium with occasional bright focus on T2 images if degeneration occurs.

The results and diagnosis of the MRI study were recorded and stored for evaluation.

The results of TVS elastography-based diagnoses were compared with MRI-based diagnoses and the values were evaluated.

Results

Out of the 84 women included in the study maximum [45.2%] were of age group between 35 years – 44 years, followed by [35.7%] in 25-34 yr. age group.

Uterine fibroids could be identified as blue-rounded areas. They appear to be darker than the surrounding tissue and are often set off from the surrounding tissue by a green border. Areas of adenomyosis had a spotted, irregular color pattern and appeared brighter than the adjacent normal myometrium. Often foci of adenomyosis with a red center surrounded by a yellow and a green irregular border could be seen.

A suitable cut-off value predictive for uterine fibroids was 1.85 and for adenomyosis was 0.54. The median strain ratio of the uterine fibroid group and the adenomyosis group were shown to be significantly different (p<0.001).

Table 1: Distribution of disease among population

	TVS	MRI
Patient with fibroid	52 [61.9%]	53 [63.0%]
Patient with adenomyosis	32 [38.0%]	31 [36.9%]

On TVS elastographic evaluation 52 [61.9%] patients were diagnosed as fibroid and 32 [38.0%] were diagnosed to have adenomyosis. In the same patients on MRI evaluation 53 [63.0%] patients were diagnosed as fibroid and 31 [36.9%] were diagnosed to have adenomyosis.

Table 2: Comparison of TVS-based diagnosis with MRI-based diagnosis

Fibroid			
	Disease	**No disease**	
Positive	52	0	Ppv: 100.00%
Negative	1	31	Npv: 96.87%
	Sensitivity: 98.11%	Specificity: 100.00%	
Adenomyosis			
Positive	31	1	Ppv: 96.87%
Negative	0	52	Npv: 100.00%
	Sensitivity: 100.00%	Specificity: 98.11%	

Transvaginal ultrasound combined with the elastography-based diagnosis was 98.11% sensitive for fibroid and was 100% sensitive for adenomyosis, whereas specificity was 100% and 98.11% for fibroid and adenomyosis respectively. The agreement between elastography-based diagnosis of fibroids and adenomyosis with MRI-based diagnosis was excellent.

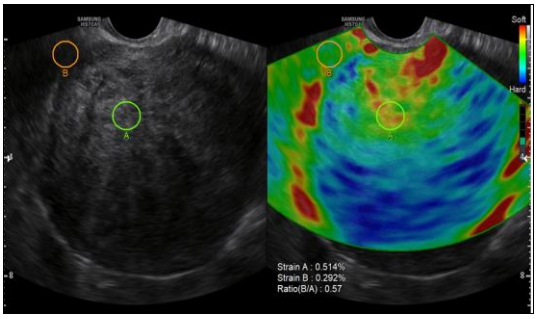

Fig 1: TVUS Elastography image in dual mode showing Adenomyosis with a strain ratio of 0.57.

Fig 2: T2 weighted MRI image of the same patient showing ill-defined lesion with cystic spaces and endometrial thickening

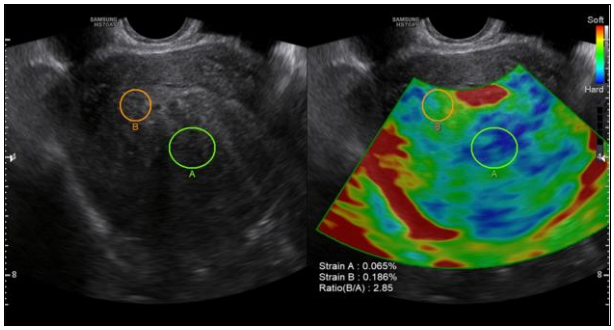

Fig 3: TVUS Elastography image in dual mode showing fibroid with a strain ratio of 2.85.

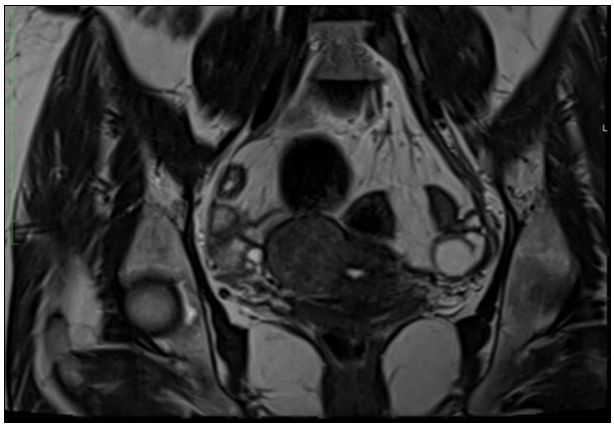

Fig 4: T2 weighted MRI image of the same patient showing well defined, heterogeneous lesion with mass effect.

Discussion

TVUS in combination with elastography can be successfully used in gynecological practice to identify various uterine pathologies, both malignant and benign [13]. Ultrasound elastography measures the stiffness of tissue. Elastography has proven its reliability in determining uterine fibroids in the case of both shear wave elastography and strain ratio elastography [14]. The study empowered us to observe the use of TVUS combined with elastography in diagnosing benign uterine lesions and to evaluate the capability of this technique to differentiate between these lesions. When compared with other non-invasive diagnostic techniques like CT or MRI, this method is significantly feasible and allows a real-time correlation between imaging and clinical findings [15]. This investigation requires a shorter examination time than MRI and involves lower costs to the patient [16]. For the final diagnosis of adenomyosis or fibroids, the reference standard used was MRI. The compliance between elastography-based diagnosis of adenomyosis and fibroids with MRI diagnosis was found to be superb. A comparison with MRI revealed that TVUS with elastography seems to be superior in terms of sensitivity and specificity, but the authors of the study acknowledged that this conclusion should be certified by future studies on larger populations [17]. The supremacy of transvaginal ultrasound along with elastography is still a matter of argument due to factors influencing its correctness. Among them, the examiner performing the procedure and his experience can influence the correct diagnosis of uterine pathologies [18]. The diagnosis of uterine fibromatosis on TVUS is easily achievable, whereas correct ultrasound diagnosis of adenomyosis is greatly influenced by the subjective perception of the examiner and his/her

experience, which can be aided by elastographic data [19].
The specificity which we achieved by using the same technique was 100% and 98.11% for fibroids and adenomyosis respectively. The positive predictive value which we obtained for fibroids was 100% whereas for adenomyosis was 96.87% with corresponding negative predictive values of 96.87% and 100% respectively. Transvaginal sonography with strain ratio elastography can be a great cost-effective alternative to conventional MR Imaging for catering in sub-urban areas and centers with no MRI availability. In our study, we found that out of 84 females, 1 female was wrongly diagnosed with adenomyosis when in actual it was a fibroid (detected using MR imaging). On research, we found out that this variation in observation was due to 'extensive degeneration with cystic spaces on strain ratio elastography' while performing transvaginal elastography for one subject. These types of cases can be challenging to diagnose accurately on just TVUS elastography imaging.

Conclusion
The elastographic data allows for the presence of a uterine fibroids or adenomyosis based on color and helps to differentiate between both focal findings in addition to that strain ratio allows for quantification of the stiffness factor. The quantitative data from strain ratio is more useful than the qualitative color-coded images obtained by elastography. Thus, the use of transvaginal strain ratio elastography in addition to transvaginal ultrasonography could help to diagnose uterine focal lesions with increased diagnostic confidence. Elastography is capable of recognizing the differentiating characteristics of fibroids and adenomyosis. Elastography-based diagnoses are in great accordance with those of MRI. With easier and cheaper availability of the sonographic setup and reduced scanning time as compared to MRI, transvaginal ultrasonography in conjugation with strain ratio can be used to make a reliable diagnosis of fibroids or adenomyosis.

Acknowledgements
The authors would like to thank the patients who participated in this study, and their families and caregivers.

Declarations
Conflict of interest: The authors declare that they have no conflict of interest.

Financial Support
Not available

References
1. Nougaret S, Cunha TM, Benadla N, Neron M, Robbins JB. Benign Uterine Disease: The Added Role of Imaging. Obstetrics and gynecology clinics of North America. 2021;48(1):193-214. https://doi.org/10.1016/j.ogc.2020.12.002
2. Neis KJ, Zubke W, Fehr M, Römer T, Tamussino K, Nothacker M. Hysterectomy for Benign Uterine Disease. Deutsches Arzteblatt international. 2016;113(14):242-249. https://doi.org/10.3238/arztebl.2016.0242
3. Drayer SM, Catherino WH. Prevalence, morbidity, and current medical management of uterine leiomyomas. International Journal of Gynaecology and Obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics. 2015;131(2):117-122. https://doi.org/10.1016/j.ijgo.2015.04.051
4. Cunningham RK, Horrow MM, Smith RJ, Springer J. Adenomyosis: A Sonographic Diagnosis. Radiographics: a review publication of the Radiological Society of North America, Inc. 2018;38(5):1576-1589. https://doi.org/10.1148/rg.2018180080
5. Görgülü FF, Okçu NT. Which imaging method is better for the differentiation of adenomyosis and uterine fibroids? Journal of gynaecology obstetrics and human reproduction. 2021;50(5):102002. https://doi.org/10.1016/j.jogoh.2020.102002
6. Frank ML, Schäfer SD, Möllers M, Falkenberg MK, Braun J, Möllmann U, *et al*. Importance of Transvaginal Elastography in the Diagnosis of Uterine Fibroids and Adenomyosis. Stellenwert der transvaginalen Elastografie in der Diagnose von uterinen Myomen und Adenomyose. Ultraschall in der Medizin (Stuttgart, Germany: 1980). 2016;37(4):373-378. https://doi.org/10.1055/s-0035-1553266
7. Sam M, Raubenheimer M, Manolea F, Aguilar H, Mathew RP, Patel VH, *et al*. Accuracy of findings in the diagnosis of uterine adenomyosis on ultrasound. Abdominal radiology (New York). 2020;45(3):842-850. https://doi.org/10.1007/s00261-019-02231-9
8. Dietrich CF, Barr RG, Farrokh A, Dighe M, Hocke M, Jenssen C, *et al*. Strain Elastography-How To Do It? Ultrasound Int. Open. 2017;3:E137-E149. https://doi.org/10.1055/s-0043-119412
9. Liu X, Ding D, Ren Y, *et al*. Transvaginal Elastosonography as an Imaging Technique for Diagnosing Adenomyosis. Reprod. Sci. 2018;25:498-514. https://doi.org/10.1177/1933719117750752
10. Zhang M, Wasnik AP, Masch WR, Rubin JM, Carlos RC, Quint EH, *et al*. Transvaginal Ultrasound Shear Wave Elastography for the Evaluation of Benign Uterine Pathologies: A Prospective Pilot Study. J Ultrasound Med. 2019;38:149-155. https://doi.org/10.1002/jum.14676
11. Dashottar S, Singh AK, Debnath J, Muralidharan CG, Singh RK, Kumar S. Comparative analysis of changes in MR imaging of pre and post-intrauterine progesterone implants in adenomyosis cases. The medical journal, Armed Forces India. 2015;71(2):145-151. https://doi.org/10.1016/j.mjafi.2015.01.008
12. Sofic A, Husic-Selimovic A, Carovac A, Jahic E, Smailbegovic V, Kupusovic J. The Significance of MRI Evaluation of the Uterine Junctional Zone in the Early Diagnosis of Adenomyosis. Acta Informatica Medica: AIM: journal of the Society for Medical Informatics of Bosnia & Herzegovina: casopis Drustva za medicinsku Informatiku BiH. 2016;24(2):103-106. https://doi.org/10.5455/aim.2016.24.103-106
13. Shao J, Shi G, Qi Z, Zheng J, Chen S. Advancements in the Application of Ultrasound Elastography in the Cervix. Ultrasound in Medicine & Biology. 2021;47(8):2048-2063. https://doi.org/10.1016/j.ultrasmedbio.2021.04.009
14. Săsăran V, Turdean S, Gliga M, Ilyes L, Grama O, Muntean M, *et al*. Value of Strain-Ratio Elastography in the Diagnosis and Differentiation of Uterine Fibroids and Adenomyosis. Journal of personalized medicine. 2021;11(8):824. https://doi.org/10.3390/jpm11080824

15. Stoelinga B, Hehenkamp WJK, Nieuwenhuis LL, Conijn MMA, Van Waesberghe JHTM, Brölmann HAM, *et al*. Accuracy and Reproducibility of Sonoelastography for the Assessment of Fibroids and Adenomyosis, with Magnetic Resonance Imaging as Reference Standard. Ultrasound in medicine & biology. 2018;44(8):1654-1663. https://doi.org/10.1016/j.ultrasmedbio.2018.03.027
16. He HY, Chen JL, Ma H, Zhu J, Wu DD, Lv XD. Value of Endobronchial Ultrasound Elastography in Diagnosis of Central Lung Lesions. Medical science monitor: international medical journal of experimental and clinical research. 2017;23:3269-3275. https://doi.org/10.12659/msm.901808
17. Stoelinga B, Hehenkamp WJ, Brölmann HA, Huirne JA. Real-time elastography for assessment of uterine disorders. Ultrasound in Obstetrics & Gynecology: the official journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2014;43(2):218-226. https://doi.org/10.1002/uog.12519
18. Van den Bosch T, Van Schoubroeck D. Ultrasound diagnosis of endometriosis and adenomyosis: State of the art. Best practice & research. Clinical obstetrics & gynaecology. 2018;51:16-24. https://doi.org/10.1016/j.bpobgyn.2018.01.013
19. Meredith SM, Sanchez-Ramos L, Kaunitz AM. Diagnostic accuracy of transvaginal sonography for the diagnosis of adenomyosis: systematic review and metaanalysis. American journal of obstetrics and gynecology. 2009;201(1):107.e1-107.e1076. https://doi.org/10.1016/j.ajog.2009.03.021

How to Cite This Article
Khanduri S, Pathak V, Surbhi, Gupta A, Goswami S, Dwari K, *et al*. Reliable diagnosis of adenomyosis and uterine fibroids using transvaginal ultrasonography with strain elastography. International Journal of Radiology and Diagnostic Imaging. 2023;6(3):17-21.