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Real-time Elastography for the assessment of Uterine disorders

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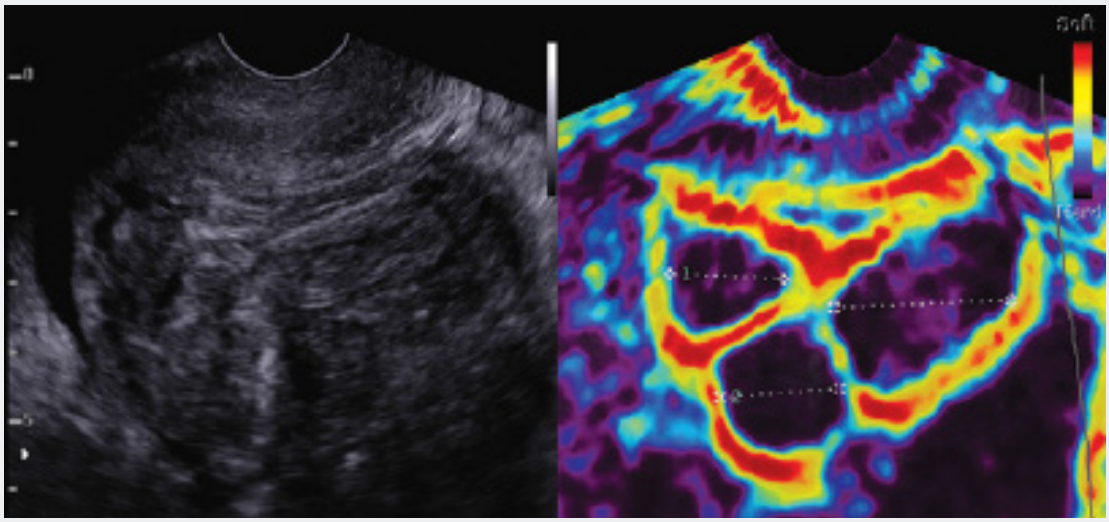

[Ultrasound Obstetric Gynecology. 2014 Feb. Cover Image]
Elastography image obtained with ElastoScan™*

"We believe elastography is a true merit in the diagnostic arsenal for benign gynecological disorders and for the differentiation between fibroids and adenomyosis. Therefore, elastography is a promising new technique in the field of gynecology."

Introduction

Elastography is widely used in diseases of the breast, prostate and liver. Its use in gynecology has not been established yet. An important clinical question in benign gynecology is the ability to differentiate between uterine fibroids and adenomyosis. Two dimensional grey scale sonography has its limitations to make a definite diagnosis in some cases. When in doubt, an MRI scan needs to be obtained. However, this is costly and usually has longer waiting time. Since adenomyosis and fibroids have a different texture (fibroids are hard; adenomyosis is softer), elastography could be of additional value.

This study was carried out to establish the elastography features of myometrium, fibroids and adenomyosis. We performed the study using with **ElastoScan™** (Samsung Medison, Seoul, South Korea), which depicts the difference in elastic motion of the tissues

*Improved fibroid mapping on dual-mode sonographic image. [Left] Conventional gray-scale ultrasound image, [Right] elastography image obtained with ElastoScan™ On the elastography image, three well-delineated fibroids are visible with a softer capsule, visualized as a lighter ring. Clear delineation of all individual fibroids is not possible in the conventional gray-scale image.

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Methods

A prospective observational cohort study was performed in an academic hospital in the Netherlands (VU medical center, Amsterdam, The Netherlands). Patients that were suspected for uterine fibroids or adenomyosis or a combination of both were asked to participate. Ultrasound scanning was performed as follows: after the 2D greyscale scan, real-time elastography was obtained with an Accuvix V10 machine (Samsung Medison, Seoul, South Korea) with elastography software (ElastoScan™) and a 4–9-MHz transvaginal probe. A 'steady state image' was defined as a reproducible steady image that delineates the uterus from the surrounding bowels for at least 40% of the surface. Furthermore, the normal myometrium should be uniform in color.

For all patients we made a 'baseline' steady-state image (holding the probe still, movement by the large abdominal arteries) and a 'dynamic' steady state image (changing pressure by intermittent movements of the probe by the observer). The dynamic image intensifies the baseline image and is specifically important for the identification of adenomyosis. All images were stored for retrospective evaluation by a blinded second observer. For this evaluation images were selected of all patients that had either MRI evaluation or histology available (reference standard). Cohen's Kappa was calculated for the diagnosis based on elastography compared to the reference test.

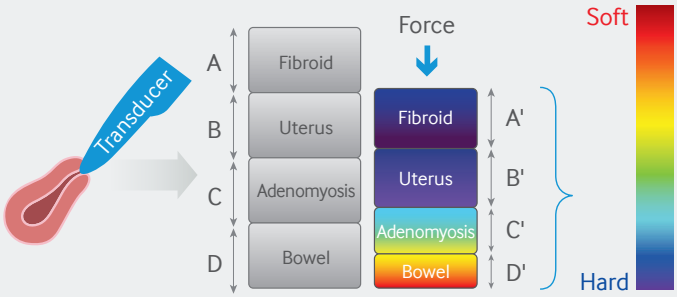

Figure 1.
Schematic diagram of use of real-time sonoelastography. The probe is used to apply pressure on the uterus, causing deformation of tissue. Deformation caused by compression depends on tissue stiffness, with more deformation in soft tissue than in harder tissue. Change in deformation is color-coded and is superimposed on the corresponding B-mode image.

Variable	Recommendation
Setting	
Blending	20%
Persistence level	80%
Color map	Ascending colors: given the ability to visualize some kind of quantification
Probe handling	
Steady state	>40% delineation of uterus from intestines; myometrium equal in color; reproducible
Baseline steady state	Keep vaginal probe still and press slightly against uterus
Dynamic steady state	Move probe gently back and forth at a frequency of one to two movements per second
Fixation	In the case of a very mobile uterus, stabilize the uterus from outside
Interpretation	
Fibroid	Center fibroid: color darker than or same as myometrium; capsule fibroid: bright parallel lines; eventual necrosis: bright spots within fibroid
Adenomyosis	Bright colors within darker myometrium; border an irregular shape
Artifacts	
Probe	Illuminated area at contact point of probe
Movement	Bright colors in the case of a non-steady-state image

Table 1. Recommendations for use of sonoelastography in gynecology, based on Samsung ElastoScan™

Result

In total 67 reference tests were available in the 218 patients that were scanned with ElastoScan™. The scored characteristics of the malformations were summarized based on the reference test diagnosis (table 2). In short, fibroids are darker than myometrium, have a distinct capsula and are well delineated. Adenomyosis is lighter than myometrium, is not well delineated and irregularly shaped. Agreement of diagnosis based on elastography is shown in (table 3).

All elastography-based diagnoses of uterine fibroids were confirmed with histology and/or MRI. For adenomyosis, there was a 100% conformation in comparison to MRI, whereas in comparison to histology agreement was reached in 71% of cases. Cohen's kappa for the diagnosis of fibroids was 1.0 with MRI and 0.80 with histology. For the diagnosis of adenomyosis this was 0.81 for MRI and was 0.64 for histology.

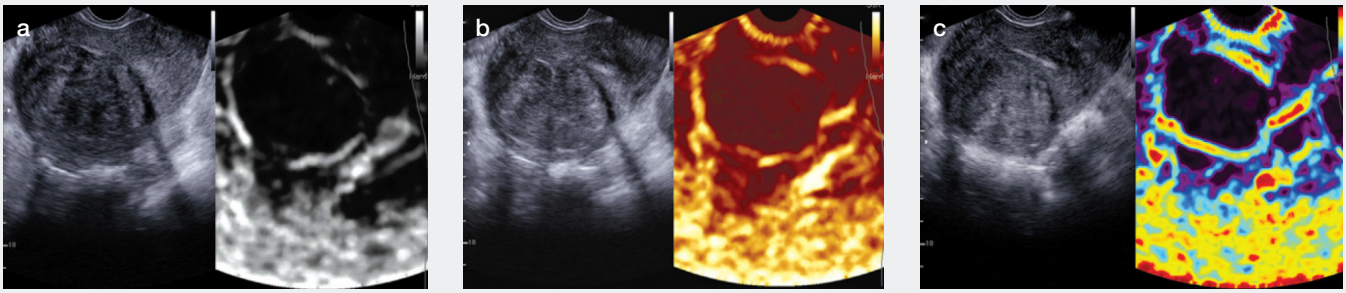

Figure 3.
Representative dual-mode sonographic images: Conventional gray-scale ultrasound image on the left and elastography image on the right (gray-scale image with color map superimposed). Different color maps can be superimposed on the gray-scale image : black and white (a), sepia (b) and ascending colors (c).

	Fibroid	Adenomyosis
Shape	Regular	Irregular
Color	>50% uniform in color	<50% uniform in color
Color center versus color myometrium	Color center darker or equal than color myometrium	Color center lighter than color myometrium
Capsula or border	Capsula brighter with respect to center	Border darker with respect to center
Capsula or border number of lines	Capsula ≥ 5 lines	Border ≤ 5 lines
Colors capsula or border	Capsula brighter from the inside to the outside	Capsula darker from the inside to the outside

Table 2. Elstographic characteristic of uterine fibroids and adenomyosis

	MRI-based diagnosis				Histology-based diagnosis			
	Fibroids	Adenomyosis	Fibroids and Adenomyosis	Other*	Fibroids	Adenomyosis	Fibroids and Adenomyosis	Others
Elastography-based diagnosis								*Other = polyps
Fibroids	15	0	0	0	54	0	3	0
Adenomyosis	0	7	0	2	0	3	2	1
Adenomyosis and Fibroids	0	0	1	0	0	0	1	0

Table 3. Agreement of diagnoses based on elastography, magnetic resonance imaging (MRI) and histology

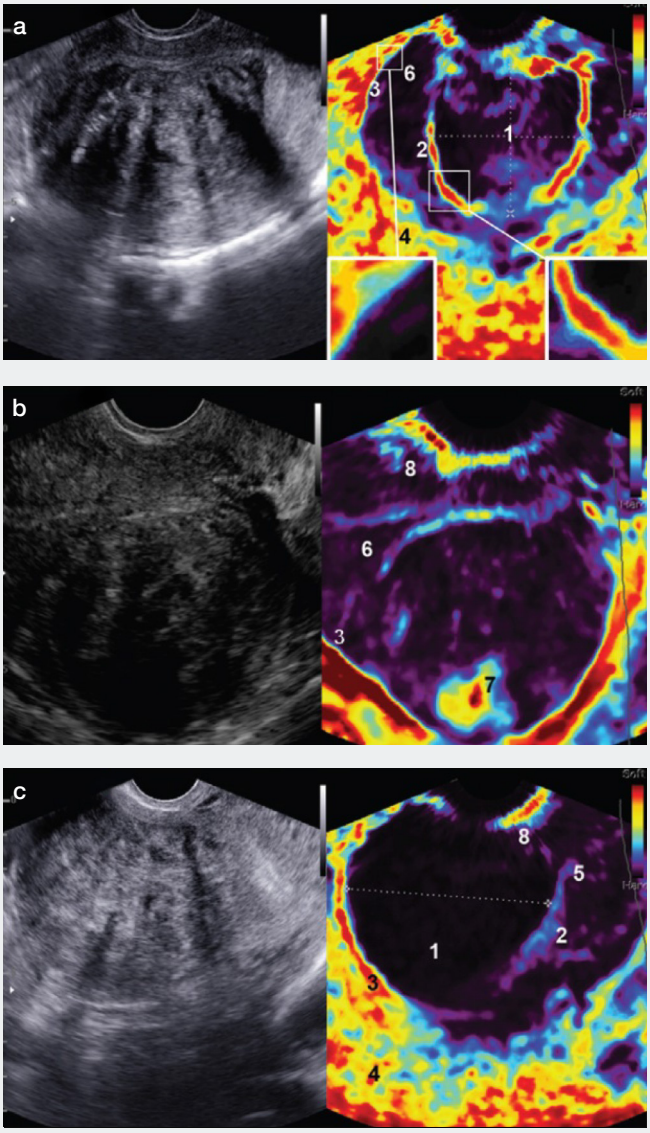

Figure 4.
Dual-mode steady-state sonographic images of different uteri (a,b,c), showing delineation of the uterus and a single intramural fibroid.

An ascending-colors map is used: dark purple or dark blue indicate harder tissue; green and yellow indicate moderately stiff tissue; and orange and red indicate soft tissue. In each elastography image (dynamic steady state), the fibroid has a regular appearance.

The capsule is well delineated with some bright parallel lines and its relation to the serosa is visible. Delineation of the fibroid is less obvious in the conventional gray-scale image.

Inset, Left) enlargement of small part of the serosa: parallel colored lines are visible.
Inset, Right) enlargement of small part of fibroid capsula: clear, colored parallel lines are identified.

1. fibroid center
2. fibroid capsule
3. serosa
4. bowel
5. endometrium
6. myometrium
7. central softening
8. probe artifact

Conclusion

This was the first study that systematically assessed the features of uterine fibroids and adenomyosis by elastography. Elastography diagnosis correlates well to MRI and histology. We believe elastography is a true merit in the diagnostic arsenal for benign gynecological disorders and for the differentiation between fibroids and adenomyosis and is therefore a promising new technique in the field of gynecology.

Supported System

(1) WS80A V1.0
(2) Accuvix A30 V1.0
(3) Accuvix XG V1.0
(4) H60 V2.0
(5) SonoAce R7 V3.0
(6) HM70A V1.0

Reference

(1) Stoelinga B, Hehenkamp WJK, Brölmann HAM, Huirne JAF. Real-time elastography for the assessment of uterine disorders. Ultrasound Obstet Gynecol. 2014 feb;43(2):218-26.

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