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## Cutting-edge application of ultrasound elastography and superb microvascular imaging in radiofrequency ablation of uterine fibroids

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Uterine fibroids are common benign neoplasms with a higher prevalence in reproductive-age women; 20%–50% are symptomatic and require treatment<sup>(1)</sup>. Failure to treat symptomatic cases is the leading indication for hysterectomy in the USA<sup>(2)</sup>. As an alternative, conservative treatment options for symptomatic uterine fibroids are on the rise. Emerging as a safer and more effective treatment option, radiofrequency ablation (RFA) consists of ultrasound-guided insertion of a coagulator into the fibroid, leading to coagulative necrosis, which can mitigate related symptoms (Video 1)<sup>(3)</sup>. RFA is widely used to treat liver tumors and thyroid nodules<sup>(4,5)</sup>.

Ultrasound (US) plays a fundamental role in RFA for the treatment of uterine fibroids. The procedure not only calls for in situ transvaginal US guidance, but also requires previous evaluation for the assessment of the lesion(s) as well as subsequent follow-up to

determine the success of the procedure<sup>(3,6)</sup>. US-guided RFA induces coagulative necrosis on viable cells or fibrous tissue, which might trigger an inflammatory response, increasing local pressure and stiffness. These histological changes occur simultaneously, altering the elasticity and vascularization of the fibroid tissue. These changes can provide qualitative and quantitative information for diagnostic and treatment purposes (Fig. 1). To this end, shear wave elastography US (SWE) can be used to evaluate the tissue's mechanical properties by measuring its response to acoustic energy, thus determining tissue stiffness. In conjunction with superb microvascular imaging (SMI), RFA can potentially become a promising tool for the treatment of fibroids with a less invasive and cost-effective approach.

SWE is a multi-wave imaging technique that measures the speed of the shear waves propagating through tissues by combining two

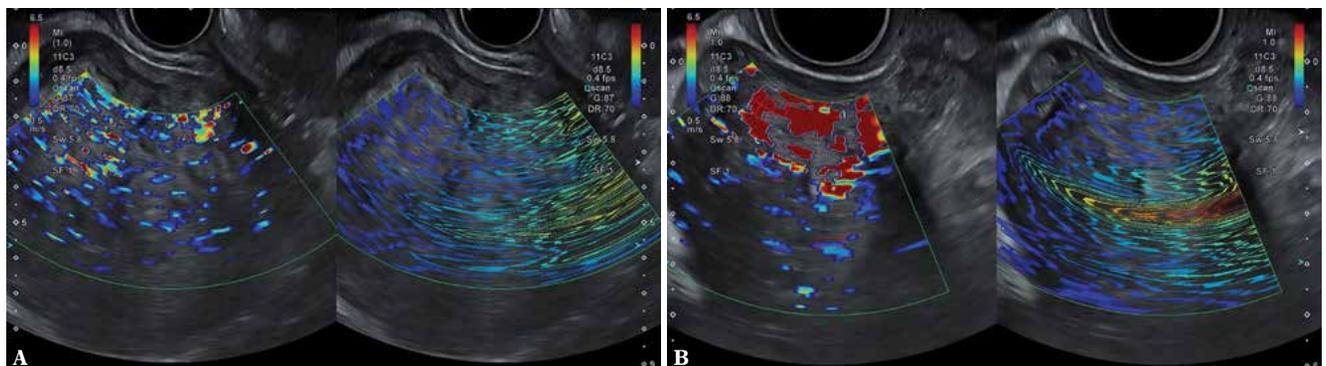
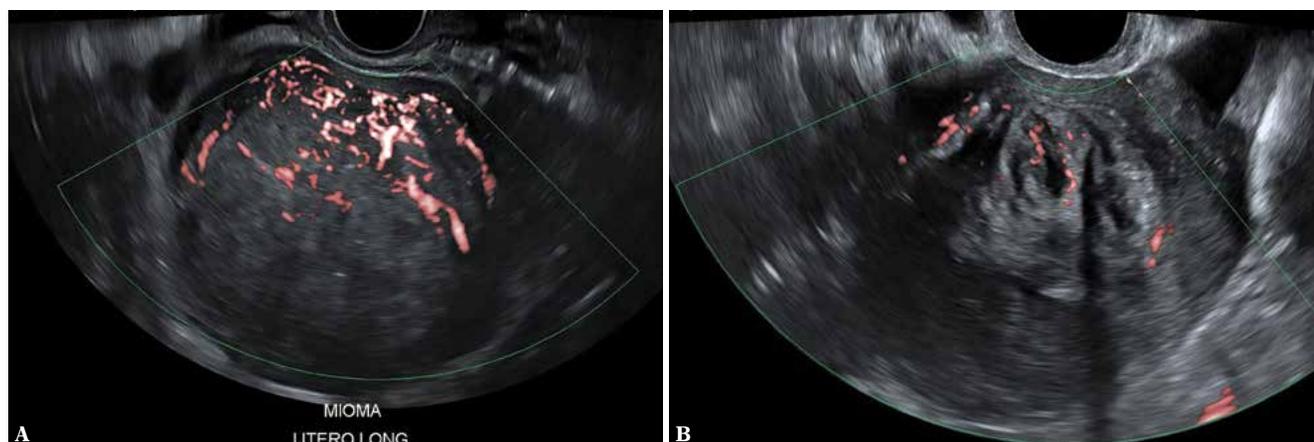


Fig. 1. Ultrasound elastography of fibroid before (A) and after (B) radiofrequency ablation. A. 2D-SWE shows blue (lower stiffness). B. 2D-SWE shows the presence of red indicating higher stiffness



**Fig. 2.** Superb microvascular imaging of fibroid before (A) and after (B) radiofrequency ablation. **A.** Moderate vascularity – peripheral and some central blood flow (up to 25% of surface). **B.** Mild vascularity – predominantly peripheral blood flow

different waves. It relies on two successive steps. Initially, a shear wave generated by an acoustic radiation force impulse is remotely induced in the fibroma with the endocavity probe through the uterus. Subsequently, the shear wave propagation is captured by imaging the fibroma. The shear modulus, that is, stiffness derived by measuring the shear wave propagation speed in m/s (or the Young's modulus, in kPa), is color-coded for each pixel and displayed as an overlay on the image in B-mode. This technology has only recently become available on end-fire endocavity transducers, explaining the limited number of published articles. Quality index and criteria are under development to improve the reliability of stiffness measurements.

SMI analyses clutter motion—through a new adaptive algorithm to identify microvasculature that is not revealed with routine Doppler technology; the increase in sensitivity is achieved by removing tissue motion artifacts, thereby revealing true blood flow<sup>(6,7)</sup>.

To the best of our knowledge, there are no clinical studies evaluating US associated with SWE and SMI for the treatment outcomes of RFA for uterine fibroids. Nevertheless, initial findings demonstrate that changes in the fibroid stiffness and vascularization after RFA might be an indicator of treatment outcome (Fig. 2). Moreover, SWE in conjunction with SMI can be an option for preoperative and postoperative evaluation of fibroids in conservative fibroid treatments.

#### Conflict of interest

*Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.*

#### References

1. Vilos GA, Allaire C, Laberge PY, Leyland N, SPECIAL CONTRIBUTORS: The management of uterine leiomyomas. *J Obstet Gynaecol Can* 2015; 37: 157–181.
2. Whiteman MK, Hillis SD, Jamieson DJ, Morrow B, Podgornik MN, Brett KM *et al.*: Inpatient hysterectomy surveillance in the United States, 2000–2004. *Am J Obstet Gynecol* 2008; 198: 34.e1–e7.
3. Chudnoff S, Guido R, Roy K, Levine D, Mihalov L, Garza-Leal JG: Ultrasound-guided transcervical ablation of uterine leiomyomas. *Obstet Gynecol* 2019; 133: 13–22.
4. Xu L, Huang B, Jiang T, Sun Z, Wang W, Xu D. Clinical value of combined contrast-enhanced ultrasound and elasticity imaging in evaluation of efficacy of radiofrequency ablation for hepatocellular carcinoma. *Int J Clin Exp Med* 2019; 12: 690–697.
5. Deandrea M, Garino F, Alberto M, Garberoglio R, Rossetto R, Bonelli N *et al.*: Radiofrequency ablation for benign thyroid nodules according to different ultrasound features: an Italian multicentre prospective study. *Eur J Endocrinol* 2019; 180: 79–87.
6. Bradley LD, Pasic RP, Miller LE: Clinical performance of radiofrequency ablation for treatment of uterine fibroids: systematic review and meta-analysis of prospective studies. *J Laparoendosc Adv Surg Tech A* 2019; 29: 1507–1517.
7. Artul S, Nseir W, Armaly Z, Soudack M: Superb microvascular imaging: added value and novel applications. *J Clin Imaging Sci* 2017; 7: 45.