J Cardiovasc Imaging. 2021 Apr;29(2):158-159
https://doi.org/10.4250/jcvi.2021.0010
pISSN 2586-7210·eISSN 2586-7296

Journal of Cardiovascular Imaging JCVI

Editorial



# High-Intensity Focused Ultrasound Induced Changes in Left Ventricular Two-Dimensional Speckle-Tracking Strain in a Mouse Model

**Sang-Hoon Seol, MD, PhD**

Division of Cardiology, Department of Internal Medicine, Inje University College of Medicine, Haeundae Paik Hospital, Busan, Korea

▸ See the article "Use of Speckle Tracking Echocardiography to Detect Induced Regional Strain Changes in the Murine Myocardium by Acoustic Radiation Force" in volume 29 on page 147.



**Received:** Jan 15, 2021
**Accepted:** Feb 1, 2021

**Address for Correspondence:**
**Sang-Hoon Seol MD, PhD**
Department of Medicine, Inje University College of Medicine, Haeundae Paik Hospital, 875 Haeun-daero, Haeundae-gu, Busan 48108, Korea.
E-mail: shseol@paik.ac.kr



**ORCID iDs**
Sang-Hoon Seol
https://orcid.org/0000-0003-3949-8777

**Conflict of Interest**
The author has no financial conflicts of interest.

The etiology and mechanism underlying diastolic heart failure is diverse.[1] Systemic diseases, such as hypertension, diabetes and infiltrative cardiomyopathies can lead to global left ventricular dysfunction. In clinical practice, myocardial ischemic changes due to coronary artery disease may cause regional wall motion abnormality of the myocardium. Echocardiography is a highly useful method for the evaluation of cardiac function. Transient ischemia, but not permanent damage, can also induce changes in the subclinical myocardium. However, such subtle changes cannot be detected using conventional echocardiography.

Myocardial strain refers to deformation (lengthening, shortening, or thickening) of the myocardium through the cardiac cycle.[2] Myocardial strain can be measured via tissue Doppler imaging or speckle-tracking echocardiography (STE). STE can be used to analyze the spatial dislocation (tracking) of each point (speckle) in the left ventricle in two-dimensional images without angle dependency.[3] It provides insight into early changes in left ventricular function. Longitudinal strain is known to be more useful for early detection of ischemia.[4] Early detection of myocardial changes based on longitudinal strain can be used to inform treatment before development of heart failure.

High-intensity focused ultrasound (HIFU) using acoustic radiation force impulse represents a strategy to reduce the temporary cardiac function without permanent myocardial impairment.[5] However, it is not easy to induce target myocardial deformation with ultrasound waves without tissue damage. The degree of damage depends on the intensity and duration of HIFU as well as the thermal effects.[6] In addition, histological analysis is needed to investigate cardiac cell damage after the HIFU pulse.

In this issue of the *Journal of Cardiovascular Imaging*, Chaudhury et al.[7] investigated the effects of acoustic radiation force, which alter the regional longitudinal strain in murine myocardium. The purpose of this study was to identify the transient changes in tissue strain during the HIFU pulse. Until now, most of the studies investigating small animals involved later stages and models with reduced systolic function.[8] Models of ischemic injury (coronary ligation, ischemia/perfusion) showed high mortality and complications due to

invasive techniques such as surgical approaches.[9][10] HIFU is relatively easy to perform and represents a non-invasive method. HFIU is a non-invasive method and has the advantage of being relatively easy to perform without surgical treatment.In this study, HIFU was used to induce early heart failure similar to myocardial ischemia in murine myocardium. An increase in regional longitudinal strain was detected with STE in all diastolic phases during acoustic augmentation. A significant change in strain involved both endocardium and epicardium.

Upon interruption, the strain returned to normal. However, the relationship between strain changes and HIFU was not known.

The significance of this study is that the changes in regional longitudinal speckle-tracking strain in small animals were detected for the first-time using ultrasound-based non-invasive cardiac stimulation. It could be used as a model for acute coronary syndrome, which causes temporary myocardial damage. In the future, further studies involving larger animal models are needed to evaluate specific changes in strain involving the left ventricle based on ultrasound pulse delivery.

## REFERENCES

1. Mandinov L, Eberli FR, Seiler C, Hess OM. Diastolic heart failure. *Cardiovasc Res* 2000;45:813-25.
PUBMED | CROSSREF
2. Trivedi SJ, Altman M, Stanton T, Thomas L. Echocardiographic strain in clinical practice. *Heart Lung Circ* 2019;28:1320-30.
PUBMED | CROSSREF
3. Mondillo S, Galderisi M, Mele D, et al. Speckle-tracking echocardiography: a new technique for assessing myocardial function. *J Ultrasound Med* 2011;30:71-83.
PUBMED | CROSSREF
4. Reant P, Labrousse L, Lafitte S, et al. Experimental validation of circumferential, longitudinal, and radial 2-dimensional strain during dobutamine stress echocardiography in ischemic conditions. *J Am Coll Cardiol* 2008;51:149-57.
PUBMED | CROSSREF
5. Marquet F, Bour P, Vaillant F, et al. Non-invasive cardiac pacing with image-guided focused ultrasound. *Sci Rep* 2016;6:36534.
PUBMED | CROSSREF
6. Palmeri ML, Nightingale KR. On the thermal effects associated with radiation force imaging of soft tissue. *IEEE Trans Ultrason Ferroelectr Freq Control* 2004;51:551-65.
PUBMED | CROSSREF
7. Chaudhury A, Wanek A, Ponnalagu D, Singh H, Kohut A. Use of speckle tracking echocardiography to detect induced regional strain changes in the murine myocardium by acoustic radiation force. *J Cardiovasc Imaging* 2021;29:147-57.
PUBMED | CROSSREF
8. Riehle C, Bauersachs J. Small animal models of heart failure. *Cardiovasc Res* 2019;115:1838-49.
PUBMED | CROSSREF
9. Gao E, Lei YH, Shang X, et al. A novel and efficient model of coronary artery ligation and myocardial infarction in the mouse. *Circ Res* 2010;107:1445-53.
PUBMED | CROSSREF
10. Lindsey ML, Bolli R, Canty JM Jr, et al. Guidelines for experimental models of myocardial ischemia and infarction. *Am J Physiol Heart Circ Physiol* 2018;314:H812-38.
PUBMED | CROSSREF