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EDITORIAL COMMENT

Strain Echocardiography

From Variability to Predictability*

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Strain echocardiography has emerged as an established and important technique in the clinical evaluation of cardiac function. Myocardial strain has been proven to add information about global and regional function and the timing of myocardial contraction beyond such traditional markers as left ventricular ejection fraction (1). Nevertheless, important questions have been raised about reproducibility, and cardiologists have questioned whether strain measurements are less reproducible than other echocardiographic parameters. The important differences in data processing between vendors, which result in variability in strain values, have also led to doubts about the credibility of strain measurements. Intraobserver and interobserver variability are obstacles researchers and clinicians must deal with on a daily basis. How to adhere to possible variability between several different vendors seems more complicated to address.

SEE PAGES 15 AND 25

In this issue of *iJACC*, 2 important studies regarding intervendor differences, reproducibility of strain measurements, and myocardial scar detection by strain are published by Mirea et al. (2,3). Similar data have been lacking previously. These papers are results of the important initiative from the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE). The 2 associations initiated the Strain Standardization Task Force in 2010; the reason for building such a task force was quite obvious. Many studies had demonstrated significant differences in strain values when 2 vendors were compared side by side. This was especially true when circumferential and radial strains were compared; longitudinal strain came out much better in most studies, but even the comparisons for longitudinal strain were far from perfect (4). The different vendors acquired strain by different techniques, and their secret algorithms, in a worst-case scenario, could prevent fruitful progress in the accurate diagnostic workup of patients. Representatives from all hardware and software vendors were invited to become members of the task force, together with leading representatives of the EACVI and ASE (5). The task force has met several times during the past few years and has had an important impact on the development and standardization of deformation imaging, as shown in these 2 papers.

The authors performed a well-designed and extensive study that included 6 different ultrasound machine vendors and 2 independent software packages. All machines were gathered in the same location, and 65 patients who had undergone a previous cardiac magnetic resonance study were examined twice on each machine by an experienced and dedicated sonographer. This was the first time that intervendor differences could be assessed in a single trial. All vendors were included in an attempt to exclude the most bias possible. The results of these studies are therefore very important and worth reading. Furthermore, the authors also managed to present these technical results in a clinically relevant and easily readable way, for which they should be applauded.

Global longitudinal strain (GLS) performed very well with regard to intraobserver variability and yielded satisfying results for intervendor variability. These results support the opinion that GLS is a sensitive and reliable marker of myocardial function, in addition to being a superior risk marker compared with ejection fraction (6). GLS has the advantage of being a robust measure and will also accurately add important information about myocardial function in relatively preserved ventricles (7).

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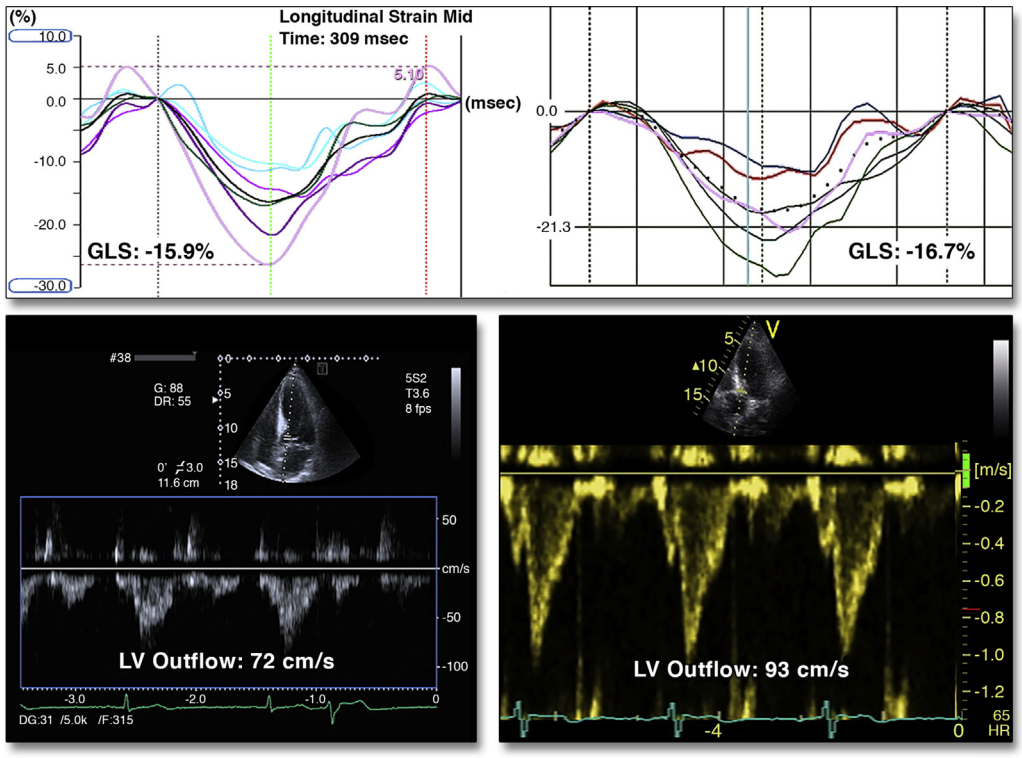
FIGURE 1 Comparison of Strain and Doppler Tracings From 2 Different Vendors



Strain **(Top)** and Doppler **(Bottom)** recordings from 2 different machine vendors (**Left:** vendor A; **Right:** vendor B) in a patient with occluded left circumflex artery. All recordings were performed within 1 h. The shape of the strain curves is approximately similar, demonstrating a lower systolic strain value, including post-systolic shortening in posterolateral LV segments. The difference in GLS is 0.8%. The lower panels show the differences in the recordings of LV outflow peak velocity between the 2 vendors. GLS = global longitudinal strain; LV = left ventricular.

The precision in identifying regional abnormality, however, differed significantly among vendors. For all vendors, the accuracy of peak systolic strain and end-systolic strain was similar, whereas post-systolic shortening demonstrated lower discrimination capacity ($p < 0.05$). Therefore, single segmental strain measurements should only be used with caution in clinical decision making, monitoring, and research. We recommend the use of peak systolic or end-systolic strain for amplitudes, whereas post-systolic shortening should be avoided. Importantly, clinicians are encouraged to use common clinical sense when interpreting strain curves, as always in medicine. One single pathologic strain curve should not necessarily lead to a conclusion of severe myocardial disease.

The authors underlined the clinical value of detecting ischemic injury and viability for prognosis after myocardial infarction. Strain measurements were correlated to late gadolinium enhancement, confirming previous results and supporting the value of strain in the clinical diagnosis of scar (8); however, in clinical practice, the presence of scar has limited consequences beyond a recognition that the patient might be at higher risk for adverse events. There are few (or no) therapeutic targets to avoid or reduce chronic scar burden, and the only possible measures to prevent complications are intensified heart failure treatment and eventually the implantation of a cardioverter-defibrillator. None of the current guidelines concerning indications to implant a cardioverter-defibrillator, however, include the evaluation of scar burden. The closest indication of a clinical value of detecting scar might be in the guidelines for hypertrophic cardiomyopathy (9), in which detection of scar by late gadolinium enhancement is mentioned as an additional risk marker for sudden cardiac death, although this is also debated and far from accepted. Nevertheless, we continue to believe that better scar detection will ultimately lead

to better risk prediction for patients in clinical practice.

A specific clinical setting in which scar detection and localization could have potential therapeutic consequences is that of lead placement in cardiac resynchronization therapy. It is accepted that cardiac resynchronization therapy lead placement in a fibrotic area can lead to less efficient pacing or even to harmful effects such as increased arrhythmogenicity. Echocardiographic assessment of scars in this setting would be very helpful (10). The present study categorized scar in no-scar and transmural scar only, that is, nontransmural scars were not evaluated. Despite this categorization, substantial intervendor differences were present in the detection of no scar versus transmural scar, and with some vendors, the difference between strain values in these 2 categories was disappointingly low. In the clinical setting, echocardiographers are exposed to a continuum of scars, ranging from transmural to diffuse, spotted, endocardial, midmyocardial, epicardial, and all variations in between.

Detection of scars has been defined as segments with strain worse than −10% in the presence of wall thinning (11). The current study, however, endorses that vendor-specific values should be used. The characterization of scar was not the purpose of these studies, but the results emphasized that there are still significant challenges to be resolved before echocardiography can replace cardiac magnetic resonance in scar detection.

Another very important piece of knowledge was recently gained from another publication from the Task Force (12). They showed that the variability of strain values was lower than for the traditional echocardiographic measures that we have taken for granted (**Figure 1**). We imagine that most cardiologists around the world have not reflected much about variability between vendors with regard to ejection fraction and left ventricular end-diastolic diameter and more. These results show, however, that simple echocardiographic measures have higher variability between different vendors than the more advanced deformation imaging techniques.

In conclusion, these papers establish GLS as an excellent measure for assessment of left ventricular function, with lower variability between different machine and software vendors than with other echocardiographic measures. We must, however, continue to recommend that each patient should be followed up using the same vendor equipment, despite good intervendor agreement. This is even more important for more traditional echocardiographic measurements and is not limited to strain measurements. Furthermore, use GLS, be careful about interpretations of segmental analyses, and continue to note suspicion on scarred myocardium for risk assessment and potentially future improved treatment.

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