Recent developments in echocardiographic speckle tracking have enabled the quantification of myocardial deformation in longitudinal, radial, and circumferential dimensions. These new techniques for assessment of deformation are much more feasible than the previous tissue Doppler-based approaches and are within the grasp of the practicing cardiologist. Indeed, clinicians ‘should’ be interested in these new approaches, which offer a level of regional and global left ventricular quantitation that has hitherto proven elusive for echocardiography. Important applications of this technique include global assessment of left ventricular function using global longitudinal strain, measurement of transmural distribution of strain, assessment of radial synchrony, and tissue characterization—e.g. in adult congenital disease. Moreover, these fundamentally quantitative approaches are very attractive from the standpoint of repeat studies, which account for a significant workload in most echocardiography laboratories, but which are limited by the measurement of the three-dimensional structure of the heart in one or two dimensions using existing technologies.

The clinician’s needs from quantitative echocardiography comprise two aspects, which may not necessarily be connected (Figure 1). The validity or accuracy of a number relates its ability to measure some external ‘gold standard’, which is sometimes of more concern to engineers than it is to clinicians. Clinicians are used to an environment of uncertainty where so many variables impact clinical presentation or outcomes that inaccuracy in the measurement of, for example, strain by a couple of percentage points may be unimportant. Reliability or precision is influenced by both random error and bias. A highly precise or reliable study will give the same measurement on sequential examinations and is a vital component of a good follow-up test. Indeed, if the study is highly precise even if it is of limited accuracy, most clinicians would find such a study useful, providing that the bias from the actual measurements was reproducible.

The results to date support the accuracy of strain measurements in validations and clinical applications, but the reliability has been less reassuring—not with respect to test–retest variation, but between equipment. Indeed, this variability in regional strain is supported by differences in the reported normal ranges of the techniques (Table 1). The higher measurements obtainable using the Doppler approach are very likely because of the higher temporal resolution of the technique and avoidance of under-sampling. The variations between speckle strain measurements likely reflect differences in the locations being tracked, as well as other aspects of processing—such as filtering—that are not apparent to the user.

The measurement of myocardial deformation using speckle tracking has the advantage of being angle-independent and being able to track segments. The known disadvantages of this approach relate to its relatively lower frame-rate compared with velocity imaging, and its susceptibility to poor image quality, which may be less of a problem with Doppler imaging as the signal/noise ratio of this modality is more favourable. However, to these limitations have been added real concerns regarding the difference in image processing and, therefore, measurements between vendors.

The report by the Hammersmith group is somewhat reassuring regarding the integration of global longitudinal strain into...
clinical practice. In this small study of 28 normal subjects, studied with two different imaging platforms, global longitudinal strain was almost identical, with some differences recorded in global radial and circumferential strain. The limits of agreement for global longitudinal strain were $-2.3$ to $3.7\%$. These results suggest that the global assessment of strain is less subject to variation than regional strain—particularly for longitudinal strain.

The clinical implications of these discrepancies are significant. Although ‘global longitudinal’ strain appears to be comparable, at the current stage of development, ‘global radial/circumferential’ and ‘regional’ strain calculations should not be considered to be transportable between vendors. Therefore, if strain is being used in longitudinal follow-up, baseline and follow-up images need to be obtained using the same system.

Strain is a fundamental physical property of a substance and could be expected to be the same, irrespective of the equipment used in its measurement, so this should be considered a very unsatisfactory state of affairs. After a decade of research, strain measurement should move into the clinical arena, but if different vendors mean different things by the word ‘strain’, the fate of this modality will surely be similar to Humpty Dumpty! There is a real need for the professional societies to establish a dialogue with the manufacturers to overcome these variations and provide a uniform standard of strain measurement which is applicable across vendors.

**Table 1** Normal ranges of strain and strain rate using different methodologies

<table>
<thead>
<tr>
<th>Longitudinal deformation</th>
<th>Studies</th>
<th>Type</th>
<th>Basal segment</th>
<th>Mid-segment</th>
<th>Apical segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic strain (%)</td>
<td>Voigt et al.</td>
<td>Doppler</td>
<td>$-21 \pm 5$</td>
<td>$-20 \pm 5$</td>
<td>$-16 \pm 6$</td>
</tr>
<tr>
<td></td>
<td>Letman et al.</td>
<td>2DS</td>
<td>$-16 \pm 4$</td>
<td>$-17 \pm 4$</td>
<td>$-18 \pm 7$</td>
</tr>
<tr>
<td></td>
<td>Marwick et al.</td>
<td>2DS</td>
<td>$-17 \pm 5$</td>
<td>$-19 \pm 4$</td>
<td>$-20 \pm 6$</td>
</tr>
<tr>
<td></td>
<td>Jurcut et al.</td>
<td>VVI</td>
<td>$-16 \pm 5$</td>
<td>$-20 \pm 6$</td>
<td>$-32 \pm 6$</td>
</tr>
<tr>
<td>Systolic strain rate (s$^{-1}$)</td>
<td>Voigt et al.</td>
<td>Doppler</td>
<td>$-1.3 \pm 0.3$</td>
<td>$-1.3 \pm 0.4$</td>
<td>$-1.3 \pm 0.5$</td>
</tr>
<tr>
<td></td>
<td>Letman et al.</td>
<td>2DS</td>
<td>$-1.0 \pm 0.3$</td>
<td>$-1.2 \pm 0.4$</td>
<td>$-0.9 \pm 0.3$</td>
</tr>
<tr>
<td></td>
<td>Jurcut et al.</td>
<td>VVI</td>
<td>$-1.4 \pm 0.7$</td>
<td>$-1.4 \pm 0.4$</td>
<td>$-1.6 \pm 0.6$</td>
</tr>
</tbody>
</table>
References


