Echocardiography and a quest of the promised land of the accurate assessment of cardiac mechanics

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This editorial refers to 'Feasibility and reproducibility of left ventricular rotation parameters measured by speckle tracking echocardiography' by Bas M. van Dalen et al., pp. 669–76, 'Interpretation of two-dimensional and tissue Doppler-derived strain (1) and strain rate data: is there a need to normalize for individual variability in left ventricular morphology?' by David Oxborough et al., pp. 677–82, and 'Echocardiographic assessment of left ventricular untwist rate: comparison of tissue Doppler and speckle tracking methodologies' by V. Ferferieva et al., pp. 683–90, in this issue.

Echocardiography is in the midst of revolution. Its cause is the emergence of the new techniques to quantify segmental systolic and diastolic function. However, as in all revolutions, 'old' ways may be held in low esteem, whereas 'new' ways are held in awe, although frequently with insufficient information to support these views.

Early in this last decade, we witnessed the emergence of segmental strain measurements based on tissue Doppler imaging (TDI). While initial studies showed good correlation with magnetic resonance imaging, later studies demonstrated that, compared with assessment of velocities, variability in the measurement of strain was much higher. Additionally, this new method required defining normal ranges of segmental strain as functions of age, gender, and wall location within the heart, work that has not yet been fully completed.1 Fast on the heels of TDI-based strain, speckle tracking echocardiography (STE) has been introduced, which enables measurement of strain in two dimensions,2 but is critically dependent on image quality and frame rate: poor image = poor data. Additionally, only a few years ago, we and others introduced measurement of LV rotation by echocardiography, first by TDI and then by STE.3 Assessment of rotation opens a completely new window to the echocardiographic assessment of heart function, but it is still searching for a compelling clinical application. Newer methods are also emerging that have enough resolution to differentiate between strain in the subendocardial and subepicardial layers4,5 and to analyse 3D data sets. Collectively, availability of these new indices has renewed interest in the relationship between cardiac function and size and maturity,6–9 but raising the further issue as to whether these parameters need to be normalized to body size?

Revolutions come and go, and the only constant is that they bring headache for many and a need for a few diligent people to clean up the mess. Echocardiography is no exception: we now have two concurrent methods for each and every parameter of segmental function. Which one is better: TDI, STE, or some hybrid measure? Also, software packages specifically designed for STE are quite different from each other: does General Electric’s EchoPac software perform the work as efficiently and accurately as Philips’s QLAB? Or Siemens’s VVI? Also, within a given software, what is the most appropriate algorithm? In these new methods, as in most of life, the devil truly is in the details.

Three papers published in this issue of European Journal of Echocardiography address some of these lingering questions. The first paper demonstrates new software for assessing torsion by STE. The second paper compares the methods of STE with TDI for the assessment of torsion. Finally, the third paper assesses whether scaling should and can be applied to strains.

van Dalen et al.10 introduce a new algorithm to quantify ventricular rotation (and thereby ventricular torsion) by STE implemented within Philip’s QLAB software. The STE algorithm of QLAB software operates in a slightly different manner from its competitors. Quite surprisingly, this software works best if it tracks a single layer of midwall myocardium (in contrast to Echopac which tracks the whole myocardial cross section, or VVI which claims to track any myocardial layer). Still this study is just a first step, the authors have not validated the software against either magnetic resonance imaging or other echocardiography methods.3,11 Furthermore, even the best method in this paper could fully analyse only two-thirds of the presented data sets.

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Ferferieva et al.\(^12\) compare the assessment of untwisting rate by two echocardiography methods, i.e. TDI and STE. They report two important findings. The first one is that, as TDI shows significantly higher values than STE (particularly with the high heart rates during dobutamine infusion), the two methods are not interchangeable. While this appears to contradict the findings of our previous study,\(^11\) Ferferieva et al. demonstrate that this difference emanates simply from the differences in sampling rate (82 Hz for STE, 183 Hz for TDI). Reduced sampling rate, in any method, serves as a low-pass filter, which predictably smooths out any peaks in the signal. This paper thus more firmly establishes that, for a certain method to be used, a consistent approach has to be applied. Finally, their paper confirms a close correlation between untwisting velocity and time constant of isovolumetric relaxation (tau),\(^12\)-\(^15\) an important finding as tau can only be measured invasively, and its proper estimation is necessary to estimate LV filling pressure and diastolic function.\(^4\)

Oxborough et al.\(^16\) embark on what seems to be a simple practical question, but also with interesting biological implications: are strains dependent on the size of the human (or to generalize the question, the size of an animal)? Some may think this question to be trivial, as human (or to generalize the question, the size of an animal)? Some may think this question to be trivial, as small: an independent parameter cannot predict variance. However, quite to our satisfaction, Figure 4 in their paper does show that subjects with smaller cavity size do have higher radial strain. An additional question is, do maturational (or simply growth) processes affect the strains? Finally, this paper did not address temporal factors (e.g. heart rate), which would be expected to have a profound impact on strain rate.

So, the quest for a perfect quantitative echocardiographic method continues. And we are still striving for a promised land: the ability to measure LV function by a simple press of a button. The silhouette of these shining hills is clear, but how long until there? These papers reflect small but important and essential steps on our journey.

References