Making a black box transparent

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Guidelines and gut feelings

Ejection fraction (EF) is known to be a valuable parameter in clinical decision-making. This knowledge has been accumulated over decades, while EF has been measured with a lot of different imaging modalities of different qualities. The interpretation of EF is always based on the gut feeling of the experienced clinician about how accurately a certain method can measure it and how reproducible it is a certain method can measure it. Therefore, in the world of clinical cardiology, cut-off values for absolute measurements or relative changes in EF will always be considered with necessary tolerance. We know that in the clinical routine we have to live with a reproducibility for echocardiographic EF measurements in the range of 5–10% and so we are often tempted to trade-off the minor gains in clinical information from guideline conform measurements with time savings gained from eyeballing. In the scientific world, however, no research paper would be accepted if EF was not measured at least using the bi-plane Simpson’s approach if not even by modern 3D volumetry. However, decades of research showing that these techniques improve the quality of our measurements have not led to a change in our attitude in the clinical echo lab, since the gain in accuracy which can be achieved in a routine setting does not outweigh the additional effort.

From the foregoing discussion, it is surprising to see how tracking-based automatic EF assessment, as offered by some vendors, is easily adapted in the clinical routine. This happens not because some papers told you that it was reliable and fast. It happens because it takes you only a few test runs until your gut feeling tells you that the method is not worse than a manual measurement and probably better than eyeballing while the gain in comfort and time is considerable.

Conversely, it is symptomatic that 15 years of echocardiographic deformation imaging has—with the exception of some expert centres—not led to a routine clinical use of strain and strain rate measurements. Researchers value the technique, since it offers insight into global and regional myocardial function in an easy and non-invasive way that is unique in cardiac imaging. Studies have shown that—on a group level—echocardiographic deformation imaging is susceptible to minimal changes in cardiac function that are missed by traditional techniques. We have learned that changes in deformation patterns are pathognomonic for certain pathological conditions, and mechanical dyssynchrony assessment would be impossible without deformation imaging. Despite papers that confirm the validity of the approach and all the evidence of its potential useful clinical applications, it is not widely accepted as a routine tool. Why? Because our gut feelings tell us that the data are not sufficiently accurate and reproducible.

This situation is potentiated if speckle tracking is attempted in 3D echocardiography. It is the merit of Badano, Muraru et al. to provide scientific evidence for this. In this issue of the European Heart Journal – Cardiovascular Imaging, they present a comparison of deformation measurements with two different ultrasound machines from two different vendors and demonstrate that there is hardly any relevant correlation on a segmental level while global circumferential, radial, and area strain parameters differ by as much as 35, 80, and 19%, respectively, in patients with good echogenicity. This is evidence for a problem in standardization. When analysing the reported inter-observer variabilities of the different strain components, it is striking that the standard deviations range from 9 to 24% of the mean measurement values in one vendor and from 20 to 130% in the other. This is evidence for a difference in quality between systems. If we set the EF variability of 10% as the maximally tolerable limit, only the area strain measurements of one vendor would pass the test.

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Reliable 3D deformation measurements would be a highly valuable addition to the echocardiographic armoury of quantification tools. The study of Badano et al., however, reports both a problem in quality of the available tracking techniques and evidence of how differently vendors define apparently simple physical parameters. The user has no chance of understanding these differences. Details of the tracking and post-processing algorithms are information proprietary to the vendors, making their software packages a black box. While this is of minor importance for the quality aspect—the problems are obvious and reproducibility has to improve—the definition of physical parameters to be measured in a heart should be (i) achieved at an open discussion with the users and (ii) should be implemented in a similar way by all vendors.

The opinions expressed in this article are not necessarily those of the Editors of the EJECO or of the European Society of Cardiology.

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In an attempt to improve this situation, the European Association of Cardiovascular Imaging (formerly European Association of Echocardiography) has initiated a task force on the standardization of echocardiographic deformation measurements. This task force is a joint effort with the American Society of Echocardiography and has received overwhelming interest from users and all major ultrasound and software manufacturers involved in the field of functional imaging. It is a manifestation of the desire of cardiologists to benefit from the advantages of new quantification methods, but also a sign of the constructive cooperation of our industry partners. The task force provides for the first time a neutral communication platform to discuss the problems inherent in current deformation imaging tools and to agree on definitions of the parameters to be measured. It might appear obvious that measuring longitudinal or circumferential strain along the endocardium, midwall, or as average of the entire wall must lead to substantial differences, but all these measurement options are used in current systems. It may be discussed whether tracking radial deformation is a robust approach or whether it should be better calculated from longitudinal and circumferential deformation, but these different approaches exist.

While all solutions have their pros and cons, a consensus on standards is crucial. This standard must not prevent future developments, but must provide confidence for the users that a certain physical feature is measured by all machines on the basis of the same definition. In a second step, commercial software must be tested to see whether it provides exact and comparable information using a common software phantom of a deforming ventricle with exactly defined ground truth. Thirdly, a study like the one by Badano, Muraru et al. can be repeated to provide evidence for reproducible results in a routine clinical setting. All this is ongoing work and first results will be communicated at the upcoming EuroEcho congress in Athens in December this year. We will see how long it takes to change our gut feelings.

References
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