Automated Versus Visual Segmental Scoring
Are We Ready to Replace the Art of Regional Wall Motion Assessment?

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Echocardiography is the most widely used noninvasive test for assessing the structure and function of the heart, accounting for 14% of overall Medicare expenditures for imaging in 2007. Despite the availability of a variety of validated quantitative methods for assessing chamber size and cardiac function, many elements of echocardiographic interpretation remain qualitative rather than quantitative. This is particularly true of the assessment of regional wall motion. Notwithstanding progress in the field of myocardial perfusion echocardiography and earlier efforts to quantitate regional function with acoustic quantitation and Doppler tissue imaging–based methods, echocardiographic assessment of regional wall motion remains the principal method by which echocardiographers make the diagnosis of coronary disease. Moreover, the ability to visually identify stress-induced regional wall motion abnormalities is the foundation for stress echocardiography.

The ability to reproducibly and reliably detect regional wall motion abnormalities is an essential skill for any physician interpreting echocardiograms and conceded to be one of the most difficult skills to acquire. Consequently, an automated quantitative approach to assessing regional function would be invaluable as a tool for the interpretation of echocardiograms for teaching and research and could prove useful in training echocardiographers.

The study of Liel Cohen in this issue of Circulation: Cardiovascular Imaging proposes just such a tool. In their article, the authors report their evaluation of a semiautomated method of measuring regional longitudinal strain to develop segmental scores, classifying segments as normal, hypokinetic, or akinetic/dyskinetic/aneurysmal. As the authors note, strain analysis based on speckle tracking as opposed to angle-dependent Doppler tissue imaging methods is appealing because it avoids translation artifact and angle dependence.

Twelve expert echocardiographers of the Israeli Echocardiography Research Group at 9 major Israeli cardiology centers used this approach as well as qualitative visual segmental scoring in 15 patients with dilated cardiomyopathy and 90 patients hospitalized for chest pain at a single medical center; 62 of these had confirmed myocardial infarction. As an initial step, receiver operating characteristic curves were used to determine values of peak systolic strain that provided the best fit with visual segmental scoring. These were subsequently used to define the thresholds that the automated system used for segmental scoring. Comparisons between the visual and automated scores were performed to analyze the agreement between the 2 approaches and interobserver and intraobserver variability of the wall motion classification each method provided. In the 83 patients in whom coronary angiography showed no or single-vessel disease, catheterization data provided the gold standard on which to assess the degree to which each method could be used to localize coronary pathology.

Liel Cohen reports that the overall interobserver and intraobserver variability was better for automated than visual segmental scoring and that even for each individual reader, intraobserver variability was better for the automated approach. Agreement in scoring between the 2 methods was achieved in 89.6% of normal segments and in 69.4% of akinetic segments but only in 39.5% of hypokinetic segments with the automated method, which is less likely to classify segments as normal, perhaps a reflection of increased sensitivity of strain analyses for detecting abnormal function. Overall, the mean sensitivity, specificity, positive and negative predictive values, and accuracy of the automated approach for identifying the culprit artery was better than the visual approach, but specificity was lower. However, the culprit artery was detected correctly with the visual method in only 44% of patients with myocardial infarction, with similar results with the automated approach (49%). These results are somewhat disappointing because, as noted in detail in the 1997 and 2003 AHA/ACC Guidelines for the Utilization of Echocardiography, regional wall motion abnormalities detected with echocardiography have previously been reported to correlate well with the site of occlusion/obstruction.

Appeal of the Study

Because this is a multicenter study that was not initiated by having all readers “group read” a set of images, this study approximates a real-world scenario, albeit one in which all readers are highly trained echocardiographers. It is likely that a prestudy joint reading session would have resulted in lower agreement.
interobserver variability estimates. Indeed, such sessions have been suggested as quality improvement tools to reduce interobserver variability in clinical echocardiography labs. However, in evaluating a new technique such as automated segmental scoring, the conservative approach to variability estimation used in this study is reasonable.

In addition, the technique evaluated requires little reader interaction—identification of the apex and both sides of the mitral annulus, adjusting the automatically tracked endocardial border as needed, and identifying segments for which image quality precluded accurate assessment. These are not skills that require advanced training in echocardiography, and the procedures involved are not time-consuming.

Although the authors do not emphasize this point, this technique has the potential to be a useful teaching and quality improvement tool, particularly for the accurate identification of normal and akinetic segments.

Reservations and Areas for Additional Study

In determining whether a new method has the potential to reduce variability, it is important to consider all potential sources of variability. In the study of Liel Cohen,6 1 major source of variability has been eliminated by virtue of limiting the analyses to a single preselected beat for each apical view. Therefore, from the perspective of variability, this is a best-case analysis, and it will be important to determine the degree to which beat selection introduces additional variability in segmental scoring. Although this may be minimal in patients in normal sinus rhythm who are free of ectopy, in patients with atrial fibrillation, beat-to-beat variability and the potential for bias in beat selection is substantial. In this regard, additional studies to address beat-to-beat variability and the potential need for pooling data from multiple beats will be important.

The analysis is also somewhat artificial by restricting the evaluator to only apical views. One of the strengths of echocardiography is its inherent redundancy, that is, the ability to image the same segments in multiple views. By eliminating the information that is contained in the parasternal and subcostal windows, the approach may be discarding good information. This may account for the relatively poor (<50%) ability to correctly localize the culprit vessel even in this group of patients without more than single-vessel disease. Similarly, by limiting the analysis to one of longitudinal strain, that is, ignoring radial and circumferential strain, the technique may fail to take advantage of all the information available from speckle tracking.

Although there was generally good agreement between visual and automated segmental scoring for the identification of normal and akinetic/dyskinetic/aneurysmal segments, agreement for hypokinetic segments was only 39.5%, and both interobserver and intraobserver variability were much poorer for identifying hypokinetic than akinetic or normal segments regardless of the approach. Because many clinically important uses of regional wall motion analysis, notably stress echocardiography, are based on identifying milder degrees of ischemic dysfunction (hypokinesis), the overall utility of this strain-based approach in clinical scenarios other than acute infarction and nonischemic myopathy remains uncertain.

The data addressing the ability of the 2 techniques to localize single-vessel culprits also warrants closer scrutiny. The analysis here is clearly a best-case scenario, as patients with multivessel disease were excluded. It would be interesting to know whether the readers were aware that patients with multivessel disease had been excluded as they performed their analyses. Arguably, such knowledge might bias a reader from labeling a segment as normal by visual scoring if the reader recognized that doing so would infer the presence of multivessel disease. Additional studies in patients with multivessel disease would be important, as would validation studies with gold standards other than coronary angiography. It also would be worth noting that there may, in the Liel-Cohen study, have been loss of sensitivity attributable to recovery of function in reperfused segments (echocardiograms were recorded up to 48 hours after admission, during which time reperfusion would surely have been attempted/ accomplished in most patients.)

When one assesses a new technology it is helpful to have a sense of what is most important—high sensitivity or high specificity. In this analysis, the qualitative visual approach has lower sensitivity but higher specificity than the automatic scoring system in identifying patients with wall motion abnormalities in territories supplied by the culprit artery. Although it is probably true that a test performed in the setting of suspected acute coronary syndrome should be highly sensitive (favoring automated segmental scoring), it is less obvious if the analysis is being performed in the setting of, for example, stress echocardiography. The potential for increased downstream test utilization, with attendant risk and cost, is concerning for a test (such as the automated segmental scoring) that identified segmental wall motion abnormalities in 32% of subjects who had normal coronary arteries. Clearly, additional validation studies in a broader range of clinical scenarios will be needed before this approach is more widely used, specifically before it is extended to the analysis of stress images.

The choice of an 18-segment model rather than the 17-segment model agreed on by the American Heart Association Writing Group and as endorsed by imaging societies9 or the 16-segment approach that is still widely used also warrants discussion. The rationale for this approach is not justified in the current study and the result is an unfortunate deviation from efforts for unified terminology. It would be interesting to know whether similar results would have been achieved using a more standard segmentation system.

Finally, it is unclear to what degree this approach relies on excellent image quality. Although the authors do indicate that 4.1% of segments were uninterpretable, it is not established whether the studies had been consecutive or preselected based on image quality.

Future Studies

This study should be viewed as an initial step in validating a new technique. Key issues that remain to be answered include the presumed additive variability introduced when beat selection is included in the assessment; the comparison of
automated versus visual segmental scoring in identifying culprit coronaries when visual segmental scoring is allowed to incorporate parasternal and subcostal views; the utility of this approach in stress echocardiography; and the potential of this approach as a teaching tool.

Conclusions
Automated segmental scoring based on longitudinal strain is a promising tool for the quantitative approach to regional wall motion assessment. This study complements prior work using velocity vector imaging (one element of which is speckle tracking) to identify regional wall motion abnormalities in patients with ischemic heart disease and argues successfully that strain-rate imaging based on speckle tracking has the potential to facilitate regional wall motion analysis. However, only time and additional studies will determine whether automating scoring will succeed where prior quantitative approaches have failed in moving to the clinical mainstream.

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Disclosures
None.

References

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