Evolution of the Study of Left Ventricular Function
Everything Old Is New Again

Blase A. Carabello, MD

The science of cardiology has evolved parallel to most medical sciences, first emphasizing anatomy, then physiology, and now molecular biology. In the 1960s, when it became obvious that effective medical and surgical therapies were available for cardiac diseases, there developed a heightened interest in measuring cardiac function as a way of evaluating the heart’s response to those therapies. Because the heart is a muscle, it was logical that measurements of muscle function would be prognostic indicators of the success or failure of a given therapy.

**See Circulation. 2002;105:1602–1608**

The cardiac muscle translates force into motion, generating cardiac output that is the product of heart rate and stroke volume. Stroke volume is dependent upon contractility (the innate ability of the muscle to generate force), preload, and afterload. Because contractility is the fundamental ability of the heart muscle to do its job, this property generated the greatest focus for measurement. The ideal measure of contractility would have the characteristics listed in Table 1. Unfortunately, despite literally hundreds of investigations, this ideal measure was never developed. Each index of function went through a typical evolution of discovery, enthusiasm, concern for imperfections, and eventual abandonment. The strengths and weaknesses of many of the indexes are listed in Table 2.1–20 The result has been that ejection fraction was chosen by the cardiology community at large and remains the index overwhelmingly used to assess cardiac function in both clinical and experimental studies. The success and persistence of ejection fraction as the common denominator of muscle function would be prognostic indicators of the success or failure of a given therapy.

**TABLE 1. Properties of an Ideal Index of Contractility**

<table>
<thead>
<tr>
<th>Number</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensitive to changes in inotrophy</td>
</tr>
<tr>
<td>2</td>
<td>Independent of load</td>
</tr>
<tr>
<td>3</td>
<td>Independent of heart size and mass</td>
</tr>
<tr>
<td>4</td>
<td>Easy and safe to apply</td>
</tr>
<tr>
<td>5</td>
<td>Proven to be useful in the clinical setting</td>
</tr>
</tbody>
</table>

© 2002 American Heart Association, Inc.
detecting abnormalities in cardiac function similar to mid-wall mean velocity of contractile shortening (VcF). One could predict from previous studies that tDi would be relatively insensitive to changes in preload but would be sensitive to changes in afterload, as is suggested by the current study. When afterload was reduced by debanding it for 2 months, tDi returned to normal, suggesting that it had been primarily an afterload mismatch that reduced tDi.

Although I agree with the authors that their tDi techniques were sensitive in detecting both systolic and diastolic abnormalities in function, I do not agree with their statement that “conventional techniques” failed to detect these abnormalities. Rather, it was the interpretation of the data that failed to detect contractile abnormalities. Concentric hypertrophy increases dP/dt. In the exercising versus sedentary rats, the ratio of thickness to radius to thickness (r/h) ratio fell from approximately 1.7 to 1.5, indicating an increase in concentricity of 12%. Concurrently, dP/dt rose by 12%, as was expected. Conversely, in the 2-month banded rats, the r/h ratio fell to 1.2, or a 30% increase in concentricity. Although dP/dt should have increased in similar fashion, there was virtually no increase in dP/dt. In fact, this lack of dP/dt increase in the 2-month banded rats despite the presence of concentric hypertrophy indicates that there was substantial left ventricular dysfunction indicated by this “conventional” parameter. If the authors had employed d-stress/dt, they almost certainly would have seen a decrease in contractility. Likewise, the presence of concentric hypertrophy should have increased an shortenning fraction, but this parameter was unchanged at 2 months, indicating a functional defect. Had mid-wall mechanics been employed, they too almost certainly would have demonstrated decreased function at 2 months. Nonetheless, tDi provides a more straightforward indicator of function without having to go through the mental gymnastics exercised above. As such, it is likely to be a useful tool. Future studies using tDi to compare the effects of changes in tDi with changes in preload, afterload, contractility, left ventricular thickness, and left ventricular dimension to define the effects of each on myocardial velocities will be necessary to place tDi in the proper perspective of its uses and limitations in examining cardiac function. I would predict that tDi will be a successful advance once it is used within the context of its known limitations. It has the advantages of being easily employed and understandable, provides some advances over ejection fraction, and should help to advance our studies of cardiac physiology. However, tDi cannot fulfill the criteria listed in Table 1 because it almost certainly will be afterload-dependent.

References

**KEY WORDS:** Editorials ■ ventricles ■ imaging ■ myocardial contraction
Evolution of the Study of Left Ventricular Function: Everything Old Is New Again
Blase A. Carabello

Circulation. 2002;105:2701-2703
doi: 10.1161/01.CIR.0000021240.86593.9D
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2002 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circ.ahajournals.org/content/105/23/2701

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published
in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial
Office. Once the online version of the published article for which permission is being requested is located,
click Request Permissions in the middle column of the Web page under Services. Further information about
this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/