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LETTER TO THE EDITOR

Definition of Left Ventricular Segments for Cardiac Magnetic Resonance Imaging

In a combined report from the American Heart Association (AHA), the American College of Cardiology, the North American Society of Cardiac Imaging, and the Society for Cardiovascular Magnetic Resonance, a consensus on left ventricular (LV) segmentation has been suggested in 2002 (1). This consensus has also been applied for cardiac magnetic resonance (CMR) (2).

The LV is divided into 3 sections: base, mid-cavity, and apex; and further subdivided into 17-segments: 6 basal segments, 6 mid-cavity segments, 4 apical segments, and the true apex as segment 17. The 17 segments correspond to specific coronary artery territories (1). This 17-segment model has been widely and successfully applied for cardiac imaging providing harmonization and guidance.

However, there are several aspects that warrant further clarification, especially for CMR imaging.

1. The definition of segments. According to the AHA guidelines the left ventricle is divided into 6 60-degree segments starting from a right ventricular (RV) insertion point for the base and middle slice. However, it is unclear, whether the anterior or inferior RV insertion point should be used (**Figure 1A ii and iii**). In addition, various manuscripts use both insertion points to delineate the septum resulting in nonequiangular segments (**Figure 1Ai**).
2. The definition of the apex (segment 17) is shown in 2 slightly different graphical displays in the original paper (**Figure 1B**).
3. The division of the left ventricle into basal, mid-cavity, and apical sections is partially inconsistent and partially based on echocardiographic information not fully transferrable to other imaging modalities such as CMR. The recommendations provide 2 different approaches.
   a. The left ventricle is divided into 3 equivalent parts along the long axis of the heart (**Figure 1Di**).
   b. The basal section is the length from the mitral annulus to the start of the papillary muscle. The mid-cavity is papillary muscle length, and the apex is beyond the papillary muscle (**Figure 1Dii**).

The 2 approaches can yield significantly different results.

The aim of this report is to provide consensus for segmenting the left ventricle based on CMR images with close alignment to the original report.

For the definition of segments within a cardiac level, the consensus panel suggests the use of both RV insertion points to define 2 major axes. For the basal and mid-cavity level, the septal and the lateral area are then further divided using an equiangular line generating 6 segments (**Figure 1Ai**). Although the resulting segments are not equiangular and thus represent different amounts of myocardium, the other alternatives would result in a misalignment of segments either at the anterior or at the inferior RV insertion point not consistent with clinical practice. Of note, the amount of myocardium for the apical, mid-, and basal slice is also different with the original suggestion due to the different mass of each slice.

Segment 17 is defined as the apex of the heart from the tip of the epicardium to the endocardium. Wall motion can be described as thickening of this segment, but no blood volume or endocardial border is assigned to this segment (**Figure 1Ci**).

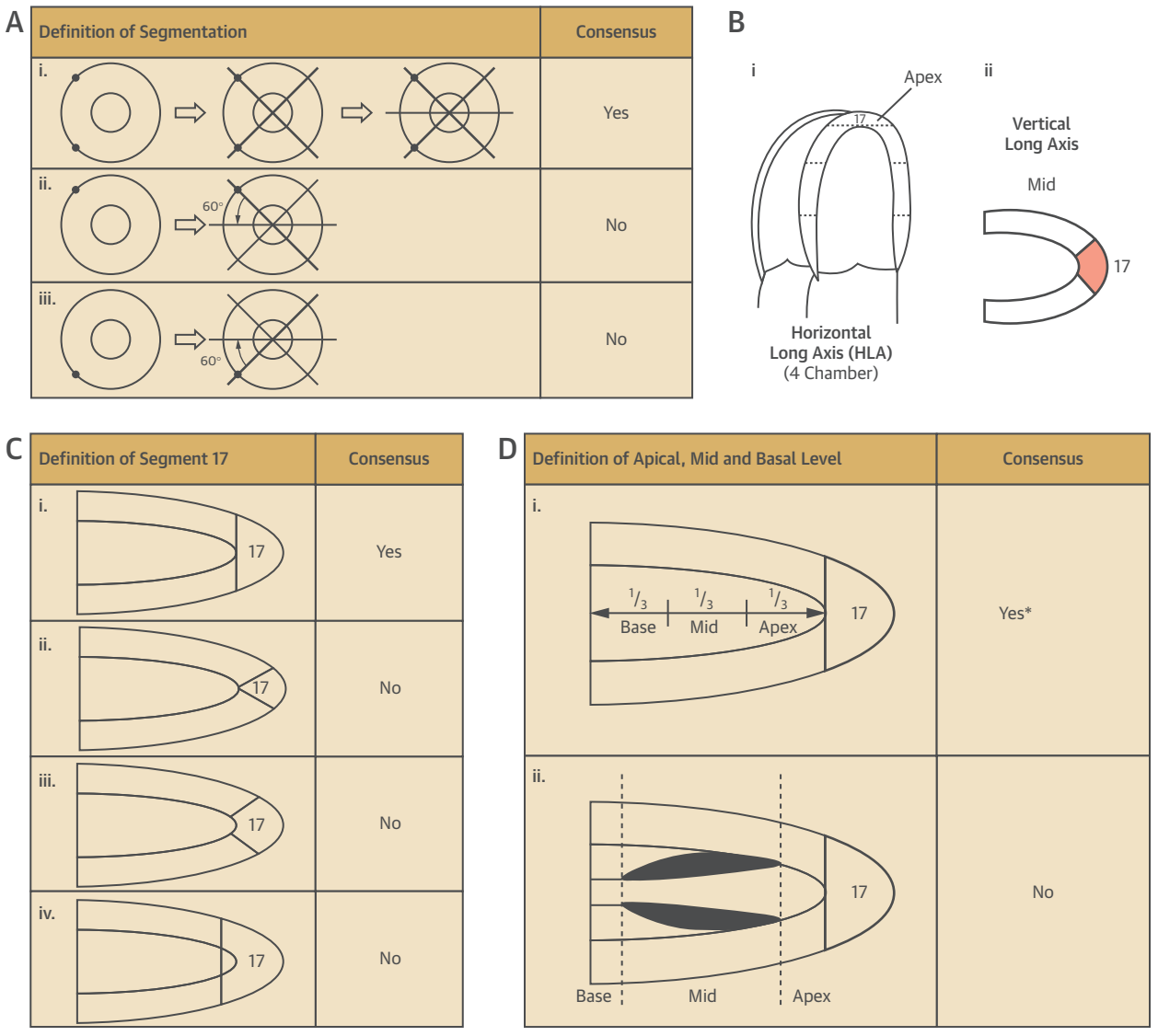
For definition of the cardiac levels (base, mid-cavity, apex), the remainder of the LV volume is divided into 3 levels with identical thickness. As such, each level describes one-third of the remaining myocardium. These levels are adapted to the cardiac cycle (i.e., different at end-diastole and end-systole) following approximately the long axis motion of the myocardium (**Figure 1Di**).

Any short axis acquired should be assigned to the respective level. It should be stated at which time-point in the cardiac cycle the assignment was performed. Assignment of short-axis slices may change over the cardiac cycle accounting for longitudinal shortening (**Figure 1D**).

Breyoni S.N. Selvadurai, MBBS, BSc
Valentina O. Puntmann, MD, PhD
David A. Bluemke, MD, PhD
Victor A. Ferrari, MD
Matthias G. Friedrich, MD
Christopher M. Kramer, MD
Raymond Y. Kwong, MD
Massimo Lombardi, MD
Sanjay K. Prasad, MD
Frank E. Rademakers, MD
Alistair A. Young, MD
Raymond J. Kim, MD
Eike Nagel, MD, PhD*

*Institute for Experimental and Translational Cardiovascular Imaging
DZHK Centre for Cardiovascular Imaging

FIGURE 1 **Schematic Drawing of Left Ventricular Segments Showing Various Options and the Recommended Consensus**



(A) Definition of segmentation. **(B)** Segment 17 **(i and ii)** (Modified with permission from Cerqueira et al. [1]). **(C)** Definition of segment 17 results. **(D)** Definition of apical, mid and basal levels results. *With adaptation to long axis changes during the cardiac cycle.

Goethe University
Theodor-Stern-Kai 7
Frankfurt 60596
Germany
E-mail: eike.nagel@cardiac-imaging.org

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Please note: Dr. Bluemke is a consultant for Siemens. Dr. Ferrari is on the editorial boards for the *Journal of Cardiovascular Magnetic Resonance* and *ACCEL*. Dr. Friedrich is an officer and advisor for Circle Cardiovascular Imaging. Dr. Kramer is a consultant for Abbott and Biotelemetry. Dr. Young has received consulting fees from Siemens. Dr. Kim is the cofounder of HeartIT, LLC; and has received a grant from Siemens Health Care. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose. Zahi A. Fayad, PhD, served as the Guest Editor for this paper.

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