Anatomy of the Atrioventricular Conduction System

To the Editor:

I am writing regarding the article by Racker and Kadish \(^1\) that appeared in a previous issue of Circulation. Their statement that “the atrioventricular (AV) node and AV bundle consist of myocardial fascicles, not myofibers” \(^1\) is inappropriate. \(^2\) Dorland’s Illustrated Medical Dictionary defines fascicle as “a small bundle or cluster, especially of nerve or muscle fibers.” The human conduction system has more collagenous connective tissue and elastic tissue than the surrounding myocardium, and this may be considered the hallmark of the conduction system histologically. \(^2\) Lev et al \(^2\) did not mention anything about nerves in their work cited by Racker and Kadish.

Racker and Kadish’s interpretation of Figures 1 and 4 from the article by Lev et al \(^2\) needs further clarification. \(^3\) They state that “Lev et al’s Figure 1 partially overlooked the proximal AV bundle, as seen in schematic AV junction region tissue blocks.” \(^3\) This statement is inaccurate. Figure 1 in the article by Lev et al \(^2\) clearly demonstrates the entire AV conduction system, including the approaches to the AV node. Likewise, Racker and Kadish’s statement that “Lev et al’s Figure 4 is, in fact, restricted to the proximal AV bundle/AV node junction” \(^1\) is inaccurate. Lev et al’s Figure 4\(^2\) is a photomicrograph of the AV node and nothing but the AV node. Further, my colleagues and I previously documented that the electrophysiological data from the AV junction more closely approximated pathological findings. \(^3\)–\(^5\)

The conduction system can be sectioned in any method one chooses and may be labeled in any way one wishes. However, it should be emphasized that the atria, ventricles, and AV conduction system are not straight in size, shape, or form. The AV conduction system is in the form of a curve or an arc. The significance of anatomy is its function. There is no anatomy without function and there is no function without anatomy. A semiquantitative analysis of the conduction system for correlative studies with electrophysiological studies can only be obtained if blocks are taken in such a manner that the entire conduction system can be followed from the beginning to the periphery and every 20th section is examined at levels of 5 to 7 \(\mu\)m.

Saroja Bharati, MD
Professor of Pathology
Rush Medical College
Rush-Presbyterian-St. Luke’s Medical Center
Chicago, Illinois


Response

Unlike what Bharati states, myocardial (and nerve terminal) fascicles with collagen encasement of the atrioventricular (AV) node and distal (and proximal) AV bundle are corroborated by direct observation in 2 different orthogonal planes and exemplify Dorland’s definition. Dr Lev and his colleagues performed a series of meticulous studies and made major contributions to the understanding of cardiac anatomy and pathology. We are aware that Dr Bharati worked closely with Dr Lev for several years and may have insights into Dr Lev’s thinking that are not in press. We were only able to comment on his published work, and we are sure that were Dr Lev alive today he would deny neither the simple, clear-cut anatomic demonstrations nor the technological advances that permitted their delineation.

Bharati is correct in stating that the article by Lev et al \(^2\) that we cited did not mention nerves. However, no mention of collagen was made either. Instead, they reported erroneously that elastic tissue surrounds the myofibers. Lev’s node is composed of a loose network of myofibers, is associated with only mitral valve connective tissue, and is not the interwoven node described by Tawara. \(^2\)

We rightly claimed that Lev et al \(^1\) overlooked the proximal AV bundle (Tawara’s atrial bundle), because the proximal AV bundle is a relatively broad tissue, comprised of parallel fascicles, that extends to the mouth of the coronary sinus, outside the right atrium and at the level of the left atrium. Innumerable ganglia are present, but they are only apparent in transverse sections, as are the 4 heart chambers. None of these attributes are depicted in Lev et al’s histological sections, which are based on the transverse plane.

Bharati claims the right “to label the conduction system as one wishes.” However, we followed the precedent set by Tawara because Tawara’s atrial bundle, node, and (distal) AV bundle are replicated in our sections. Bharati is correct in stating that blocks must be taken so that the full conduction system can be followed. However, such block(s) must be inclusive of the proximal AV bundle (and the atrionodal bundles), and the plane of the section is critical for specific observations.

Significantly, correlated functional studies corroborate our anatomic designations for the AV junction’s specialized and ordinary atrial tissues \(^4\) by (1) tissue-specific extracellular and intracellular electrical potentials and conduction properties recorded during direct observation of the AV node and simultaneous recordings from all the tissues \(^5\) and (2) by restriction of iontophoresed Lucifer yellow to fascicular compartments of the dye-injected myocyte. \(^7\)

Darlene K. Racker, PhD
Alan H. Kadish, MD
Departments of Medicine and Cardiology and the Feinberg Cardiovascular Research Institute
Northwestern University Medical School
Chicago, Illinois

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Circulation. 2001;103:e63-e64
doi: 10.1161/01.CIR.103.12.e63
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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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/103/12/e63

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