Abstract—Current nomenclature for the atrioventricular (AV) junctions derives from a surgically distorted view, placing the valvar rings and the triangle of Koch in a single plane with antero-posterior and right-left lateral coordinates. Within this convention, the aorta is considered to occupy an anterior position, although the mouth of the coronary sinus is shown as being posterior. Although this nomenclature has served its purpose for the description and treatment of arrhythmias dependent on accessory pathways and atrioventricular nodal reentry, it is less than satisfactory for the description of atrial and ventricular mapping. To correct these deficiencies, a consensus document has been prepared by experts from the Working Group of Arrhythmias of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. It proposes a new anatomically sound nomenclature that will be applicable to all chambers of the heart. In this report, we discuss its value for description of the AV junctions, establishing the principles of this new nomenclature. (Circulation. 1999;100:e31-e37.)

Key Words: anatomic nomenclature ■ atrioventricular junctions ■ triangle of Koch ■ atrial mapping ■ accessory pathway ablation

The introduction of catheter ablation has revolutionized the approach to treatment of arrhythmias. In the 1970s, surgery developed as a very effective means of curing the Wolff-Parkinson-White syndrome.1,2 The accessory pathways responsible for preexcitation and tachycardias were identified by mapping,3 and their structure was confirmed by pathologic observations.4,5 The atrioventricular (AV) junctions, defined as the AV rings and surrounding structures, and including Koch’s triangle and the AV conduction tissues, were described in great detail. The nomenclature developed at that time, however, depicted the position of the AV rings and the aortic valve in one plane, which was described on the basis of antero-posterior and right-left lateral coordinates. In this plane, the aortic valve is represented as being anterior to the mouth of the coronary sinus, when in reality it is predominantly superior. Similarly, the coronary sinus itself, which becomes the main landmark in the presumed posterior part of the section, is properly described as being inferior.6

Despite the obvious distortion introduced by this nomenclature, it served its purpose to permit communication between electrophysiologists and surgeons and was fundamental in the evolution of surgical and catheter ablation in the treatment of Wolff-Parkinson-White syndrome. But as AV nodal reentrant tachycardia became better known (and subject to surgical treatment), the same inaccurate nomenclature was applied to Koch’s triangle7–9 This resulted in definition of anterior and posterior approaches to the AV node, which again are inappropriate descriptions of the true anatomic orientation because during life, the apex of Koch’s triangle points up and not to the front. In contrast, those who have also considered the treatment of ventricular tachycardia have described their findings using appropriate anatomic coordinates.10

Such discrepancies now achieve greater importance because, with the development of catheter ablation, treat-


†Dr Ronald W.F. Campbell is deceased.

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ment of accessory pathways and nodal tachycardia has largely become the province of the electrophysiologist but with the retention of surgical nomenclature. Because the electrophysiologist must navigate around the heart under fluoroscopic control, with the heart viewed as in the setting of the anatomic position of the patient, the terms used by the surgeon and adopted by electrophysiologists no longer relate accurately to the location of the heart in the body.

Whereas the target of ablation was the substrate for abnormal AV conduction, the success of the procedures disguised the need for anatomically correct terminology, because the operators learned to guide their catheters around the AV rings irrespective of the accuracy of the words used for description. Current extension of ablative procedures to treat atrial and ventricular arrhythmias now makes it advisable to use terms which not only describe accurately the AV rings and the adjacent chambers, but also, at the same time, make it possible to describe them correctly in reference to the anatomic position.

As a solution to this problem, the Working Group of Arrhythmias of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology have convened panels of experts to work together to provide an anatomically accurate nomenclature. This document reviewing the anatomic position and nomenclature of the AV junctions is the first result of this joint effort. We have chosen the term AV Junctions to include the AV rings and the more complex septal and paraseptal areas containing the AV conduction structures, as well as many AV accessory connections. Once the true anatomic coordinates are applied to the AV junctions, the anatomic location of all cardiac structures should become easy to describe. However, the authors recognize the need to extend this effort in the near future to the even more complex anatomy of atria and ventricles.

The Root of the Problem

Descriptions of the locations of the accessory connections responsible for the Wolff-Parkinson-White syndrome are currently made relative to the AV junctions as seen in the left anterior oblique radiographic projection (Figure 1). The descriptive terms used, however, are anatomically inaccurate. The superior aspect of the heart is described as being anterior, whereas the anterior and posterior aspects are described as right and left lateral (Figure 2). Reference to the location of the heart as seen in the anatomic position (Figures 3 and 4) demonstrates the inaccuracy of this approach. This mismatch between current nomenclature and true anatomic position engenders major problems in teaching the appropriate movement of catheters in the electrophysiology laboratory and underscores inaccuracies in correlating the electrocardiographic patterns of preexcitation with the location of accessory muscular AV connections.

The fluoroscopic screen presents the thorax in an upright image, even if the patient is recumbent. This facilitates recognition of anatomic positions by showing superior structures in the upper part of the screen, such as the superior caval vein, and inferior ones in the lower part, such as the inferior caval vein. Oblique and lateral views give no problems in defining antero-posterior directions because the spine and the sternum are clearly recognizable as reference markers. Nonetheless, according to current nomenclature, the trainee in electrophysiology is taught to move the catheter anteriorly from the inferior caval vein to reach the His bundle, even though the catheter is seen to move upwards on the screen during this maneuver. Similarly, the trainee is taught to move the catheter posteriorly from the superior caval vein to reach the mouth of the coronary sinus, when in reality the catheter is seen to move down.

The obvious distortion of logical thinking provoked by this nomenclature is well portrayed in left anterior oblique or lateral fluoroscopic views. In these projections, the position of the His bundle and mouth of the coronary sinus are approximately equidistant from the spine and the sternum (Figures 5 and 6), but the His bundle itself is superiorly positioned relative to the coronary sinus. Another obvious distortion is the designation of accessory pathways located in the upper margins of the mitral ring as
being anterior. In the left anterior oblique view, such pathways can be seen to be close to the spine and hence, in reality, to be relatively posterior (Figure 5). A further example is the designation of those accessory pathways which insert in the lower part of the parietal tricuspid ring as being posterolateral, whereas these pathways really occupy an inferior and anterior position (Figure 6). Such distortions would be of relatively little importance if only the AV junctions had to be mapped. The problems are greatly exacerbated, however, when mapping is extended to include the atria. Current nomenclature prevents any accurate description of the posterior and anterior atrial walls and makes impossible the logical understanding and teaching of endocardial mapping (Figure 7).

Because vectorial analysis of the ECG is also based on the anatomic position, patterns of preexcitation are similarly difficult to explain logically when current nomenclature is taken literally. Thus, for the beginner, it is unclear why a presumed posterior accessory connection should produce negative delta waves in the inferior leads. When posterior is translated to inferior, then the correlation immediately becomes easy to understand and to teach. The same can be said for left lateral accessory connections producing R waves, or right lateral connections producing negative QRS complexes.

Figure 3. A, Horizontal magnetic resonance cut of the heart through the mitral and tricuspid planes, atria, and ventricles. B, Schematic reproduction of A with appropriate labels. L indicates left; LA, left atrium; LV, left ventricle; R, right; RA, right atrium; and RV, right ventricle. C, Oblique sagittal magnetic resonance cut of the heart, parallel to the plane of the atrioventricular valves (dotted line in B), showing the position of the mitral and tricuspid valvar orifices and the aortic root in the left anterior oblique view as in Figure 4. D, Schematic reproduction of C with appropriate labels. The main direction of the valvar planes, marked by the dotted line, is from anterior (right) to posterior (left). Ant indicates anterior; Ao, aortic root; M, mitral valve; Post, posterior; and T, tricuspid valve.
in right precordial leads V1-V3. Probably because of this nonanatomic nomenclature, it has been necessary to construct rather complex diagnostic algorithms to provide clinical correlations, and these are often used in preference to intuitive vectorial analysis.\textsuperscript{23–26}

**Basis for an Anatomically Correct Nomenclature**

For the purposes of anatomic description,\textsuperscript{6} the body is viewed in the upright position and has 3 orthogonal axes: superior-inferior, posterior-anterior, and right-left (Figure 2). The same axes are used in description of the ECG and also in fluoroscopic projections. The atria are fixed in the thorax by the connection of the pulmonary and caval veins together with the attachment of the arterial trunks. The position of the ventricles, and hence the AV junctions, is more variable. The axis of the ventricles tilts laterally to the left from base to apex, extending anteriorly and slightly inferiorly, with the AV junctions following the orientation of the ventricles. The junctions, nonetheless, have a relatively constant relationship to the bodily coordinates. It is recognized that the so-called right atrium and ventricle are more accurately described as anterior to the left atrium and ventricle, respectively; however, we hesitate to challenge this traditional designation at this point.

**Anatomically Correct Description of Catheter Positioning**

An accurate account of the coordinates of the valvar orifices is provided by the simple expedient of relating appropriately the view obtained in left anterior oblique projection to the supero-inferior and antero-posterior coordinates of the body. The tricuspid valvar orifice, with its leaflets occupying antero-superior, inferior, and septal positions, can then be considered in terms of superior, superior paraseptal, septal, inferior paraseptal, inferior, antero-inferior, anterior, and antero-superior sectors (Figure 8). Within these coordinates, the central fibrous body and the bundle of His are located in the superior septal region of the tricuspid valvar circumference (Figures 5 through 7). The mitral and tricuspid rings, are adjacent inferiorly, separated in the region of off-setting of the valvar leaflets by an area of overlapping atrioventricular muscular contiguity. More superiorly, the subaortic outflow tract is interposed between the mitral valve and the septum. Using the correct anatomic coordinates, the parietal part of the left AV junction, which supports the mural (postero-inferior) leaflet of the mitral valve, can then be described accurately as possessing superior, postero-superior, posterior, postero-inferior, and inferior sectors (Figure 8).

**Fluoroscopic Guide to Mapping the AV Junctions to Localize Accessory Pathways**

Accessory muscular pathways are mostly localized within the AV fat pad close to the endocardial aspect of the AV junctions. Their anatomic classification follows the orienta-
Anatomic: **RIGHT ANTERO-INFERIOR**

Current: **RIGHT POSTERO-LATERAL**

In the electrophysiological laboratory, assessment of the orientation of the junctions is almost always based on information derived from the fluoroscopic image after the insertion of multiple electrode catheters into the heart.

Because the right and left AV junctions are superimposed in the anterior-posterior projection, and even more in right anterior oblique views, precise localization is achieved by using the left anterior oblique view (compare Figures 1 and 3, 5 through 7). This allows recognition of the right and left free walls and the distinction of these parietal zones from the septal area. Because the coronary sinus is positioned within the left atrioventricular junction, and drains inferiorly and rightward as it extends to reach its right atrial termination, a multiple electrode catheter inserted within the sinus permits accurate localization of most left-sided accessory pathways, particularly when maneuvered additionally into the great cardiac vein. After localizing the accessory pathway, an ablation catheter can be positioned at either the atrial or ventricular aspect of the junctions. In the electrophysiological laboratory, assessment of the orientation of the junctions is almost always based on information derived from the fluoroscopic image after the insertion of multiple electrode catheters into the heart.

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AV junction, opposite to the position of the electrodes within the coronary sinus or cardiac vein marking the site of the pathway. Accessory pathways localized in the septal and paraseptal areas are mapped with an electrode catheter introduced either from the right or left side; the catheter is maneuvered within a space which is limited superiorly by the His-bundle catheter and inferiorly by the catheter introduced through the mouth of the coronary sinus. Mapping and ablation around the tricuspid junction is usually performed from the atrial aspect, using a catheter which can be moved around the entire junction. Representative examples of catheter positions taken around the right and left junctions, and profiled in right and left anterior oblique views, are shown in Figures 5 and 6. Mapping of the right atrium (Figure 7) underlines still further the importance of an anatomically correct designation of anterior and posterior positions so as to understand atrial anatomy and related arrhythmias.

Conclusions

By applying anatomically appropriate designations to the sectors of the AV junctions as viewed in the fluoroscopic screen, we are able to provide a system of description that is both simple and accurate. Use of the terms proposed will permit the operator to maneuver catheters under fluoroscopy in entirely logical fashion, a facility not provided by existing terminology (Table). Understanding of patterns of preexcitation as seen on the ECG should also be facilitated, on the basis of traditional vectorial analysis. The system of description produced will be equally valid in locating the different parts of the atrial and ventricular chambers, and it will prove particularly helpful when using the new gener-

	

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References


Current Nomenclature and Proposed Terminology

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Proposed terminology is based on anatomic positions.


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