COMMENTARY

AV Dissociation, an Inevitable Response

Kyuhyun Wang, M.D., and David G. Benditt, M.D.

From the Cardiovascular Division, Department of Medicine, University of Minnesota Medical School, Minneapolis, MN

Background: The independent activation of the atria and ventricles, AV dissociation, is a common phenomenon that occurs during a wide variety of electrophysiologic circumstances. The clinical significance of AV dissociation is often misunderstood.

Methods: This article examines the basis and clinical implications of AV dissociation.

Results: AV dissociation is often an obligatory, secondary phenomenon, and should not be construed as the primary disorder; it may be due to either the AV conduction system being completely blocked (3° AV block) or the P wave and the QRS complex being generated from separate sources (usually, the AV junction or ventricle) but occurring close together during the physiologic refractory period of each other. The latter may happen in junctional or ventricular arrhythmias including escape or accelerated rhythm, tachycardia, or premature beats.

Conclusion: The crucial clinical point is not the AV dissociation itself, but that an underlying triggering primary disorder is present and should be identified.

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AV dissociation; AV block; tachycardia; interference dissociation

Atrioventricular (AV) dissociation is a phenomenon that occurs frequently, yet confusion and misunderstanding surround it.[1–3] For instance, it is not unusual for the term to be used synonymously with complete AV block (CHB). While CHB does exhibit AV dissociation, this usage is not correct. The purpose of this article is to clarify the concept of AV dissociation and facilitate appropriate use of the term.

AV dissociation is defined as an independent activation of the atria and ventricles. Atrial activation is triggered by one pacemaker (usually the sinus node and rarely an atrial focus), while the ventricular activation is initiated by another (either the AV junction or a ventricular focus). CHB (3° AV block) results in AV dissociation (in the absence of atrial standstill, which is quite rare), but not every case of AV dissociation is due to CHB. There are many other situations that result in AV dissociation in the absence of AV block.

Interference AV Dissociation

Cardiac tissue, after depolarization, must repolarize before it can respond to subsequent stimuli (i.e., the tissue is said to be refractory). In this regard, the physiologic refractory period of cardiac tissues comprise both absolute as well as relative components, both of which impact transmission of the cardiac impulse, and may establish a basis for AV dissociation.

During sinus rhythm (or, rarely, atrial rhythm) if a QRS complex triggered from another source (AV junction or ventricle) occurs close in time to the P wave, such that the P wave and the QRS fall during the physiologic refractory period of each other (or that of the AV node), the impulse from the atrium cannot conduct to the ventricle and the impulse from the ectopic source cannot conduct to the atrium; AV dissociation results. This situation is sometimes called "interference dissociation" because two pacemakers are interfering with the

Address for correspondence: David G Benditt, M.D., Mail Code 508, 420 Delaware St, SE Minneapolis, MN 55455. Fax: 612-624-4937; Email: bendi001@umn.edu

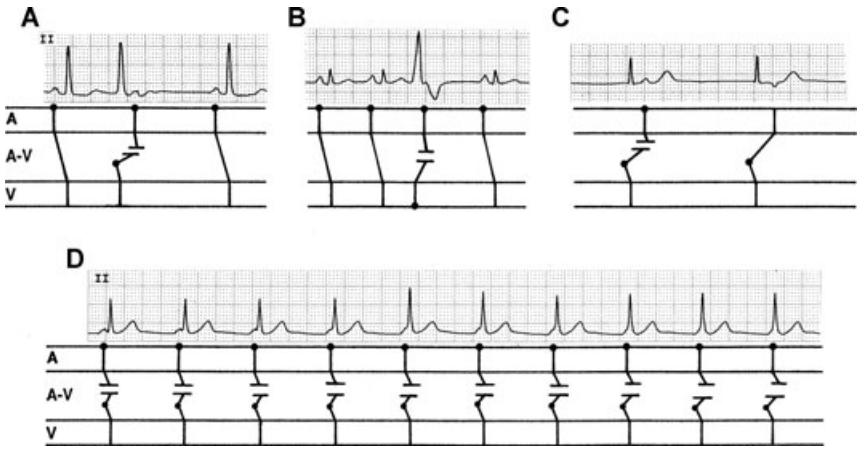

Figure 1. AV dissociation with: **(A)** Junctional premature beat. **(B)** Ventricular premature beat. **(C)** Junctional escape beat. (The second junctional impulse conducts to the atria because the atria have not been occupied by the sinus impulse and are available). **(D)** Junctional pacemaker is accelerated to 75/min, which happens to be almost identical to the sinus rate and AV dissociation results.

propagation of each other's impulse, whereas the AV dissociation from CHB has been called "block dissociation" (a rarely used term).[4] Dissociation in these circumstances is an obligatory or inevitable response in that, faced with either a physiologic refractory period or AV block, the P wave and the QRS from another source have no other way to behave but to dissociate.

Normally, the sinus rate is faster than the rate of subsidiary pacemakers; consequently, their pacemaker capability is not given a chance to manifest. However, it is possible for the rate of subsidiary pacemakers to approach that of the sinus by either slowing of the sinus rate, a pause in the sinus rhythm, speeding of the subsidiary pacemaker, or a combination of these. Interference dissociation may occur with a junctional escape beat, a ventricular extrasystole, or a series of beats as in accelerated junctional or ventricular rhythm or ventricular tachycardia. Situations that may result in AV dissociation are listed in Table 1 and examples of some of these are shown in Figure 1.

Not all QRSs derived from nonsinus subsidiary pacemakers will result in interference AV dissociation. The prerequisite for AV dissociation is that the QRS from the ectopic source has to occur close enough in time to the sinus P wave so that the two pacemaker sources initiate impulses that fall in each other's refractory period or the refractory period of intervening tissues (e.g., the AV node). If the P wave occurs outside the refractory period of the AV conduction system or ventricular myocardium, the impulse from the atrium will conduct to the ventricle—ventricular capture. If the ectopic impulse reaches the atria when they have not yet been activated by the sinus impulse and therefore are not refractory, the impulse will conduct to the atrium retrogradely—atrial capture. These capture beats interrupting dissociation are useful since they prove the absence of AV block, either anterograde or retrograde.

Figure 2 illustrates how AV dissociation may develop in the absence of AV block. Sinus rhythm is present at the beginning. The third QRS originates from the AV junction, which is accelerated and occurs slightly before the next sinus beat is due. The impulse from the AV junction cannot conduct to the atrium since the atrial tissue is physiologically

Table 1. Situations that can result in AV dissociation

A. Some cases of:
- AV junctional escape beat or rhythm
- AV junctional premature beat
- Accelerated AV junctional rhythm
- AV junctional tachycardia
- Ventricular premature beat
- Accelerated idioventricular rhythm
- Ventricular tachycardia
- Ventricular paced rhythm

B. All cases of:
- Complete (3°) AV block

Figure 2. AV dissociation during accelerated junctional rhythm. See text for explanation.

refractory because it has just been depolarized by the sinus impulse. The sinus impulse cannot conduct to the ventricle since the AV conduction system is physiologically refractory because it is depolarizing; AV dissociation results. The same situation repeats itself during the subsequent three QRSs. Notice that the P wave gradually falls behind the QRS as the sinus rate gradually slows further. This will eventually allow the AV junctional impulse to conduct to the atrium (atrial capture) resulting in a negative P wave as happens following the last QRS in the upper panel and the first two QRSs in the lower panel. But before the atria are fully captured, the gradually ascending retrograde impulse effects partial capture producing two fusion P waves (F), that is, part of the atria is activated by one pacemaker, the rest by the other. Thus, two pacemakers (sinus node and AV junctional pacemaker) are competing to capture the atria.

As the sinus rate speeds up gradually in the lower tracing, the sinus impulse regains control of the atria resulting in positive P waves but not soon enough to conduct to the ventricles; the ventricles continue under the control of the AV junctional pacemaker and AV dissociation again results. Eventually, as the sinus rate speeds up further and clearly precedes the junctional impulse, it not only controls the atria, but also is able to conduct to the ventricle as happens with the last three QRSs.

It is clear that the AV dissociation in the middle of the upper and lower tracings happens because the AV junctional pacemaker is accelerated and discharges slightly ahead of the sinus impulse so that the P waves and the QRSs fall within each other's physiologic refractory period. The absence of AV block, anterograde or retrograde, is clearly demonstrated. The primary disorder in this case is AV junctional acceleration; if it were not for that, there would have been perfectly normal sinus rhythm. AV dissociation is an inevitable secondary response of the conduction system to the primary disorder. Sorting out the primary disorder and the secondary responses will allow more logical treatment of the condition. The important question is not whether the P waves and QRSs are dissociated, but why the AV junctional pacemaker is accelerated—it could be due to digitalis intoxication, myocardial ischemia, or infarction, etc.

One may wonder why in interference dissociation the sinus and ectopic rates are almost identical as in tracing "D" of Figure 1. Rather, that is the required condition for dissociation to occur. If the sinus rate is much faster than that of the subsidiary pacemaker, the sinus pacemaker would not allow the subsidiary pacemaker a chance to become manifest. Similarly, if the subsidiary pacemaker accelerates to a much faster rate than the sinus rate, retrograde conduction to the atria will result, as

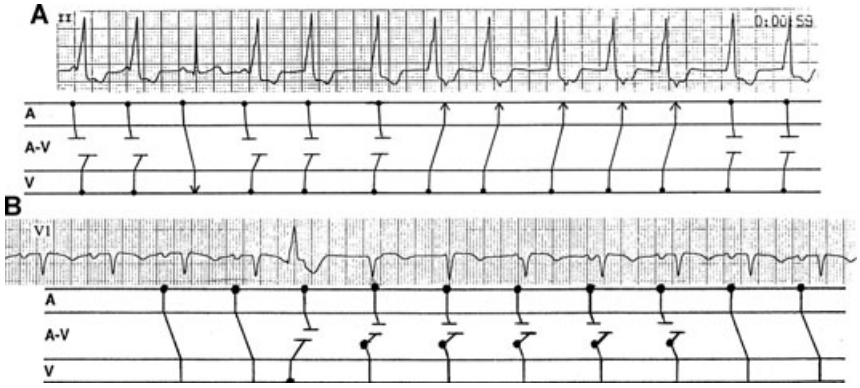

Figure 3. (A) Accelerated idioventricular rhythm with AV dissociation. One ventricular capture (3rd QRS) and five atrial captures (retrograde conduction to the atria) are also present. **(B)** An example of interference dissociation in which the sinus rate (71/min) is faster than the junctional rate (67/min). The compensatory pause following a ventricular premature beat is slightly longer than the junctional escape interval and allows the junctional pacemaker to escape for several beats, resulting in AV dissociation.

happens in tracing "A" of Figure 3. In this latter tracing, the same accelerated idioventricular beats result in AV dissociation at times and retrograde conduction to the atria at other times. If the atria are already captured by the sinus impulse and therefore are not available to the ventricular impulse (i.e., refractory), AV dissociation results. If the atria are not yet captured by the sinus impulse, the atria are available to the ventricular impulse and retrograde atrial capture results. Thus, whether the QRS from an ectopic source is going to result in AV dissociation or not depends on whether the sinus P wave lurks nearby or not.

AV Dissociation in Complete (3°) AV Block

AV Dissociation in CHB has been called "block dissociation"[4] in contrast to interference AV dissociation. All cases of CHB result in AV dissociation naturally because the AV conduction system is completely blocked either transiently or permanently. Since not all cases of AV dissociation are due to CHB, the term "AV dissociation" should not be used synonymously for CHB.

It has been said that in interference dissociation, the ventricular rate is faster than the atrial rate and in CHB, the ventricular rate is slower than the atrial rate. In general, that is the case. Otherwise, sinus rhythm would not allow a subsidiary pacemaker chance to become manifest. However, that is not how AV dissociation is best understood. Rather, it should be understood that in CHB, no matter how the P wave is timed in relation to the QRS, the impulse will not conduct to the ventricles because the AV conduction system is completely interrupted. Conversely, interference dissociation results only if the P wave and the QRS from another source occur close together, so that they fall within a physiologic refractory period (i.e., a physiologic conduction block). In fact, in CHB, the atrial rate can be slower than the ventricular rate if the sinus rate is slower than that of the escape rhythm (for instance, in some cases of sinoatrial disease, or as a result of drug effects), or if the escape rhythm is accelerated to a rate faster than the sinus rate. Similarly, interference dissociation can occur transiently even when the ventricular rate is slower than the atrial rate. For example, if the compensatory pause after a ventricular premature beat or a pause from resetting of the sinus pacemaker is longer than the AV junctional escape interval, AV junctional pacemaker may manifest for several beats resulting in AV dissociation until the sinus impulse overtakes the junctional rhythm. Tracing "B" in Figure 3 is such an example.

SUMMARY

The term AV dissociation indicates the presence of independent excitation of atria and ventricles, and is an inevitable secondary phenomenon in

response to any of several primary rhythm disorders. It is the primary disturbance that is important (e.g., ventricular tachycardia or accelerated junctional rhythm, etc.) and the focus of any proposed treatment.

Neither anterograde nor retrograde AV block is necessary for AV dissociation to occur, and consequently, AV dissociation is not synonymous with CHB. Thus, while AV dissociation does occur in the setting of complete heart block (whether permanent or transient), it also occurs under circumstances when AV conduction remains intact (i.e., interference dissociation). Finally, whether the atrial rate is slower or faster than the ventricular rate does not necessarily distinguish CHB from interference dissociation.

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