Bypass Tracts Revisited

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The study of atrioventricular bypass tracts remains an educational cornerstone for students of electrophysiology seeking to understand the principles of reentry, mapping, tachycardia mechanism diagnosis in the electrophysiology laboratory, and ablation. Surgical and subsequently catheter ablation procedures to eliminate these tracts derived from an understanding of their anatomic location, typically bridging the atrioventricular annulus allowing conduction from atrium to ventricle to bypass the normal atrioventricular node. With this appreciation of anatomy and physiology, pacing maneuvers can be applied and interpreted to clarify the presence and electrophysiological properties of atrioventricular bypass tracts in the electrophysiology laboratory.

Confirming PV Activation

The first step is to show that potentials recorded from the vein are not produced by adjacent structures (eg, the LAA when recording from the left PVs), by showing that pacing within the PV does capture the local PV myocardium. The next step is to demonstrate that the earliest PV signal is not at the ostium, but within the vein. Without bypass tracts, the left atrium is the source for PV activation, and PV signals are earliest at the ostium and become progressively later as the catheter is moved deeper into the vein. With a bypass tract that inserts distal to the ostium, the antrum is activated later than the more distal PV tissue.

VOM Connections

High and Low Output Pacing in the CS for VOM Connections

High output pacing in the CS proximal to the VOM captures left atrium and CS myocardium, but at low output may capture only the CS myocardium. If there is no change in the timing of the PV potential between high and low output pacing (with CS and LA capture compared with capture of the CS alone) then a bypass tract is present and depends only on the CS myocardium to activate the PV myocardium via the VOM.

Pacing within the VOM will pull in the PV signals, activating them earlier, whereas pacing at other sites outside the PV (eg, the LAA) fails to do so.

Ablation of the VOM tissue or all of its connection can be difficult, but may be achieved by a variety of approaches:

1. Transmural ablation at the endocardial ridge anterior to the left PVs.
2. Ablation within the VOM by selective cannulation of the VOM via the CS.
3. Alcohol ablation of the VOM with selective cannulation via the CS.
4. Epicardial ablation by placing the catheter within the transverse sinus and then pulling back along the course of the VOM in the sulcus between the LAA and PVs.2,3

**PV to PV Bypass Tracts**

Myocardial bridges distal to the ostium that occur between individual PVs are particularly likely to occur when a narrow common ostium is present with later branching between the 2 PVs.4,5 When wide area circumferential ablation is done and both ipsilateral veins are isolated simultaneously, these bypass tracts are irrelevant. However, when individual PV isolation is done, then persistent PV conduction may occur through one of these tracts. Pacing in the ipsilateral vein will pull in the signals that remain in the vein that is already encircled with ablation lesions. Care must be taken to avoid direct capture of the adjacent vein by pacing in the ipsilateral vein on the side facing away from the vein being mapped. For example, if left upper vein isolation is failing to achieve entrance block, then pacing is performed in the left lower vein on its inferior wall.

**LAA to Left PV Tracts**

The VOM and left superior vena cava sulcus creates a plane of separation between the posterior wall of the LAA and the anterior wall of the left PVs. Some patients have myocardial connections that bridge this sulcus and diagnosis can be difficult. When this occurs, delineation of far-field signals arising from the LAA cannot be demonstrated in the usual manner by pacing in the LAA because the direct connection will cause the PV potentials to be pulled. In patients who have had a LAA closure device placed, pacing maneuvers may not be possible from within the LAA.

**Confirming the Diagnosis**

1. Depending on where these bypass tracts occur, the earliest PV activation is at that site distal to the ostium.
2. Pacing on the anterior wall of the LAA will pull in the PV signals with the same activation sequence.
3. Pacing on the posterior wall of the left PV will cause early activation within the LAA.

**Ablation**

1. During pacing of the left PV posteriorly, an activation map of the LAA can be created and the earliest site of activation targeted for ablation energy delivery.
2. If the LAA has been occluded with an endocardial device, circumferential isolation around the device of the LAA may be necessary to isolate the left PVs.

**Right Atrium/Superior Vena Cava to Right PV Bypass**

Patel and colleagues1 elegantly describe a set of patients where targeted mapping and ablation of fibers that bypass the left atrial ostium and directly connect the anterior wall of the right PVs to the right atrium or superior vena cava. These tracts are perhaps the best recognized of those described in this perspective.6,7 In addition to the inability to isolate the vein, these bypass tracts may constitute a limb of a reentrant circuit that involves the right atrium, left atrium, and the right-sided PVs when a gap in the encircling PV line is present. When slow conduction is present related to this gap, the tachycardias may be easily induced or incessant. Re-isolation of the vein or ablation at the right atrial entrance site for the bypass tract will terminate the macroreentrant tachycardia, but for isolation of the vein, both the left atrial gap and bypass tract must be eliminated.

**References**

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