Accessory pathway location algorithms: Planning invasive procedures in the electrophysiology laboratory

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The development of more precise mapping tools and new catheters have dramatically changed the landscape for the ablation of accessory pathways (AP) for conditions such as Wolff-Parkinson-White (WPW) syndrome [1]. Non-fluoroscopic navigation systems and smaller catheter tips with irrigation capacities have led to changes in terminology for specific anatomical targets of ablations and have also led to greater rates of success, defined as elimination of the electrocardiogram (ECG) manifestation and arrhythmia inducibility [2, 3]. As a result, previously developed ECG algorithms to anatomically locate accessory pathways may need to be reviewed, as the sensitivity and specificity of such algorithms were calculated when the tools were less precise.

Today, electrophysiological study (EPS) and ablation are considered the gold standard for the treatment of WPW syndrome with a high success rate of approximately 95% and a low rate of complications [4, 5]. The approach to patients suitable for ablation involves first locating the AP using the pre-procedural ECG. This allows the operator to consider additional tools or methods that may be necessary during the intervention (i.e. transeptal puncture [TSP], use of cryoablation, use of coronary sinus [CS] venograms, coronary angiography) or to determine the risk of AV node block due to the proximity of the AP to the conduction system [6].

In a multicenter retrospective cohort from Italy, Ferrari et al. [7] proposed a novel approach to AP location in children, aiming to assess and compare the accuracy of the algorithms proposed by Arruda [8], Boersma [9], and Chiang [10]. The authors enrolled 120 patients younger than 18 years of age who underwent a successful ablation of one AP between January 2013 and June 2019. Three cardiologists blindly analyzed the resting pre-procedural ECG of all patients and applied the previously mentioned algorithms. These were validated against fluoroscopy projections and electroanatomical maps, which were considered the gold standard for AP location at the time. Notable findings of this study include the following:

- All the analyzed algorithms had strong discrimination between right-sided and left-sided pathways, with the highest accuracy reached by Arruda et al. [8] at 93% concordance.
- When the pretest probability was taken into consideration, the location of the AP was correctly predicted by the Boersma (84%), Arruda (83%), and Chiang (67%) algorithms.
- The algorithm of Chiang had the highest positive predictive value (PPV) for identifying APs with a high septal location and, therefore, at risk of developing AV block during ablation (72%).
- Agreement between algorithms to predict left-sided AP location was reasonable between Boersma and Chiang (κ = 61%) and was moderate between Arruda and Boersma (κ = 45%) in predicting risk of AV block.

The authors implemented a step-down approach based on the concordance of the

3 algorithms to identify left-sided APs and sites at risk of developing AV block. Using this strategy, when concordance was present, right- vs. left-sided APs were correctly identified in 96.4% of cases, and prediction for the development of AV block vs. no block was accurate 92.2% of the time.

Ferrari et al. [7] allow us to draw conclusions that are aligned with our recently published approach [6]. Our Simplified Topographic Algorithm (STA) aimed to provide a perspective on ECG location in the context of today's improved procedural tools to assist with EPS and ablations. In that article, we discussed the reasons why older AP location algorithms have important limitations such as anatomical variation (especially in children), inconsistent anatomical nomenclature, degree of pre-excitation affecting the ability to locate pathways, technical aspects (e.g. lead positioning), differences in the approaches for mapping (surgical or endocardial), the requirement for atrial pacing during the ablation procedure, septal locations and understudy of pediatric populations [6]. From our perspective, before an AP ablation procedure, the interventional electrophysiologist must consider the following:

- Is TSP required to access the left atrium?
- Are CS venography and coronary angiogram required?
- What is the risk of AV node block in the case of septal or parahisian pathways?
- Are additional tools needed (e.g. for cryoablation)?

Similar to the approach discussed in the work of Ferrari et al. [7], the STA considers 3 anatomical regions for potential AP location: the left lateral wall, the posteroseptal wall, and the right anterior to the free wall. For the implementation of this simplified approach, six leads (V1, I, aVL, II, III, and aVF) are used in a stepwise manner:

- Step 1: Left lateral wall: The most common location of the AP (55%), identified by a positive delta wave in V1 and negative or isoelectric delta wave in leads I and aVL.
- Step 2: Posteroseptal wall: The second-most common area (30%), characterized by a negative delta wave in at least two of leads II, III, or aVF. Further, the right-side origin is suspected if III is more negative than II, and the left-sided location, possibly within CS, is more likely if a notched QS is observed in lead II, and lead V1 usually presents a positive delta wave.
- Step 3: Right anteroseptal to free wall: This is the least common location (<10%) and is characterized by negative delta waves in lead V1 and positive ones in leads II, III, and aVF.

AP location through ECG algorithms remains of significant interest to clinical and interventional cardiologists to better characterize procedural risks and enhance the success of the ablation. The approach designed by Ferrari et al. [7] is a major contribution to planning ablation procedures in children. A detailed analysis of these data and integration of this algorithm into our clinical practice may help to reduce time in the electrophysiology laboratory, minimize complications, and provide patients and families with appropriate outcomes.

Article information

Conflict of interest: None declared.

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