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PII: S2214-0271(22)00197-X
DOI: https://doi.org/10.1016/j.hrcr.2022.10.003
Reference: HRCR 1417

To appear in: HeartRhythm Case Reports

Received Date: 17 August 2022
Revised Date: 22 September 2022
Accepted Date: 3 October 2022

Please cite this article as: Uniat J, Silka MJ, Risk Assessment of Pre-excitation: Atrial Fibrillation vs Atrial Flutter, HeartRhythm Case Reports (2022), doi: https://doi.org/10.1016/j.hrcr.2022.10.003.

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Risk Assessment of Pre-excitation: Atrial Fibrillation vs Atrial Flutter

Short Title: WPW Risk in Atrial Fibrillation vs Atrial Flutter

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The authors have no conflicts to disclose.

Total Word Count: 1,192
Keywords: Pre-excitation, Wolff-Parkinson-White syndrome, Sudden death, Ablation, Risk stratification

Introduction:
Risk stratification for the potential of sudden cardiac death (SCD) in young patients with Wolff-Parkinson-White (WPW) syndrome remains a somewhat controversial and imprecise exercise. While clinical parameters such as unexplained syncope or a family history of WPW may correlate with increased risk, most commonly the risk is estimated based on parameters observed during episodes of clinical tachycardia or variables measured during electrophysiology study (EPS). While variables such as the antegrade accessory pathway effective refractory period or the shortest paced cycle length with pre-excitation during atrial pacing are commonly used, the shortest pre-excited R-R interval (SPERRI) during atrial fibrillation is a generally considered the measurement which best defines the risk of SCD, due to rapid antegrade conduction resulting in ventricular fibrillation. In this report, we describe a patient with a high-risk accessory pathway whose SPERRI significantly shortened during sustained atrial flutter compared to SPERRI measurements in atrial fibrillation or other programmed stimulation parameters. The mechanism for this observation and the implications regarding risk stratification in young patients are discussed.

Case Report:
This patient is a 16-year-old female with WPW and episodes of supraventricular tachycardia (SVT) since the neonatal period. Due to increasingly frequent and prolonged episodes of SVT with symptoms including severe chest pain and near-syncope, she was referred for EPS and catheter ablation. Her baseline ECG demonstrated ventricular pre-excitation with a pattern consistent with left antero-lateral accessory pathway (Figure 1).

At diagnostic EPS, local ventricular pre-excitation with earliest activation was identified at the distal coronary sinus catheter. Ventricular pacing also demonstrated eccentric and non-decremental ventricular-atrial conduction at the antero-lateral aspect of the coronary sinus. The antegrade accessory pathway effective refractory period was 270 ms with 600 ms cycle length drive train. There was persistent antegrade accessory pathway conduction with rapid atrial pacing at 260 ms. Induced orthodromic reciprocating tachycardia converted into atrial fibrillation with a single interval SPERRI of 228 ms; however, the majority of R-R intervals were in the range of 350-400 ms (Figure 2). Atrial fibrillation then spontaneously converted to atrial flutter with a sustained ventricular cycle length of 195 ms due to consistent 1:1 A-V accessory pathway conduction with maximally pre-excited QRS complexes (Figures 2 & 3) and loss of demonstrable cardiac output. Atrial flutter terminated spontaneously to normal sinus rhythm during preparation for DC cardioversion. Radiofrequency catheter ablation was then performed with complete elimination of bi-directional accessory pathway connection.

Discussion:
In patients with WPW, it is generally accepted that the risk of sudden death is related to the characteristics of the accessory pathway(s). The mechanism of sudden death is reported as atrial fibrillation with rapid antegrade accessory pathway conduction leading to ventricular fibrillation. However, this patient demonstrated high-risk accessory pathway characteristics with the SPERRI during
Atrial fibrillation ≤ 250 ms in one R-R interval only. Conversely, the SPERRI further shortened during atrial flutter with sustained 1:1 AP conduction at a cycle length of 195 ms.

For adult patients with WPW, high-risk is defined as the SPERRI during atrial fibrillation ≤ 250 ms, the presence of multiple accessory pathways, an accessory pathway refractory period ≤ 240 ms, or atrioventricular reentrant tachycardia precipitating pre-excited atrial fibrillation. For children, catheter ablation is recommended for those with a SPERRI ≤ 250 ms, those with structural heart disease for which an arrhythmia may result in poor hemodynamics, or those who have developed ventricular dysfunction. However, it has also been reported that patients with life-threatening events may have accessory pathway properties that are not deemed high-risk and low threshold for ablation should be considered.

Atrial flutter and atrial fibrillation are proposed to be related entities and may transform into one another as demonstrated with our patient. This was associated with a significant decrease in the pre-excited R-R interval (195 ms) and cardiovascular collapse. The change in the SPERRI is consistent with concealed conduction during atrial fibrillation resulting in variable prolongation of the accessory pathway refractoriness but with more uniform repolarization during atrial flutter allowing 1:1 conduction. This raises an important point when patients with WPW are deemed to have low-risk pathways based on EPS testing and the type of atrial arrhythmia (atrial fibrillation vs atrial flutter) that measurements are obtained. The transition of atrial fibrillation to atrial flutter with very rapid sustained conduction may offer a possible explanation for the higher incidence of sudden death in young patients with WPW syndrome compared to older patients.

**Conclusion:**

Invasive risk stratification for pediatric patients with WPW is imperfect. The relationship of atrial fibrillation (with concealed conduction) and atrial flutter (absence of concealed conduction) may offer an explanation for sudden death or life-threatening events in children who have low-risk pathways by invasive electrophysiologic testing. Catheter ablation should be considered at time of EPS if safe and feasible.
Figure 1: Baseline ECG tracing demonstrating ventricular pre-excitation of left antero-lateral accessory pathway. The QRS complexes are significantly different than those with maximal pre-excitation in figures 2 and 3.
Figure 2: Surface ECG tracing of abrupt transition from atrial fibrillation to atrial flutter. Note the somewhat irregular pre-excited QRS complexes with abrupt transition to very rapid, regular and maximally pre-excited QRS complexes.
Figure 3: Intracardiac electrograms demonstrating the transition from atrial fibrillation with variable AP conduction to atrial flutter and consistent 1:1 AP conduction.

2. Pediatric and Congenital Electrophysiology Society (PACES), Heart Rhythm Society (HRS), American College of Cardiology Foundation (ACCF), et al. PACES/HRS expert consensus statement on the management of the asymptomatic young patient with a Wolff-Parkinson-White (WPW, ventricular preexcitation) electrocardiographic pattern: developed in partnership between the pediatric and congenital electrophysiology society (Paces) and the heart rhythm society (HRS). *Heart Rhythm*. 2012; 9:1006-1024. PMID: 22579340


Key Points:

1. Due to concealed conduction, the shortest pre-excited RR intervals during atrial fibrillation and atrial flutter may differ significantly.
2. Either atrial fibrillation or atrial flutter may be a substrate for sudden cardiac death for individuals with ventricular pre-excitation.
3. Pediatric patients with WPW have a higher incidence of sudden cardiac arrest compared to adults.