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Serial assessment of accessory pathway antegrade conduction in children

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Abstract There is limited longitudinal data on accessory pathway (AP) antegrade conduction throughout childhood, with implications for risk stratification. Ten patients underwent serial electrophysiology study (EPS) with assessment of fastest 1:1 AP conduction. The median age at first and follow-up EPS was 0 (median 4 days) and 53 months. Median fastest 1:1 AP conduction was 255 ms at initial EPS and 275 ms at follow-up ($P = 0.24$). The interval of time between studies had no influence on stability over time, nor was there any appreciable effect following changes in retrograde AP conduction. In conclusion, no patient displayed any marked shortening of 1:1 AP conduction over time.

Keywords: Accessory atrioventricular pathways; Children; Risk assessment; Longitudinal study

Introduction

Approximately 1–3 per 1000 individuals have a cardiac accessory electrical connection allowing bypass of the atrioventricular node (AVN) and pre-excitation of the ventricle, an arrhythmogenic substrate eponymously named Wolff-Parkinson-White (WPW) [1]. Some accessory pathways (APs) exhibit brisk antegrade conduction during atrial fibrillation, with the attendant risk of rapid ventricular depolarization that degenerates into ventricular fibrillation. Although the denominator remains elusive and the literature contentious, current best estimates of this risk for ventricular fibrillation for "all-comers" with ventricular pre-excitation is ~0.05% annually [2]. The most established measures of AP behavior correlated with risk of sudden cardiac death include the following parameters: shortest pre-excited R-R interval during induced atrial fibrillation, fastest 1:1 AP conduction during incremental atrial pacing, and AP effective refractory period [1]. Although it has been generally accepted that AP antegrade conduction behavior is static throughout childhood, there is a paucity of longitudinal data on AP conduction in children. If AP antegrade conduction is not brisk at the time of an electrophysiology study in a young child, to what extent does that finding provide reassurance for later in childhood? Given the clinical practice of diagnostic transesophageal pacing studies in infants with supraventricular tachycardia at our institution, there is a local cohort of patients who have undergone characterization of AP antegrade conduction over time. Extrapolating from observations in several published adult cohorts [3,4], we hypothesized that there will be no significant difference in established measures of AP risk profile over time.

Methods

A retrospective review was conducted of all pediatric patients (age ≤ 18 years) with ventricular pre-excitation who underwent 2 or more electrophysiology studies (EPS) (transesophageal or invasive) at a single institution from January 2000 through June 2014. The primary objective was to compare the first and last quantitative assessment of antegrade AP conduction properties. Patients were excluded if all pacing studies were performed within a single 3 month time span, or if one of the pacing studies was performed: (1) in the presence of maintenance anti-arrhythmic medication, (2) with only intermittent antegrade AP conduction, (3) following attempted ablation of the AP, or (4) without standard assessment of antegrade AP conduction. Additionally, patients with ventricular pre-excitation arising from an atriofascicular or fasciculoventricular accessory pathway were excluded. Clinical data collected included gender and history of resuscitated cardiac arrest, syncope or spontaneous antidromic reciprocating tachycardia (ART). For each pacing study, data collected included age at time of study, type of pacing study (transesophageal versus invasive), procedural sedation, presence of retrograde accessory pathway conduction, inducible ART, and AP antegrade conduction assessment at baseline and with isoproterenol infusion,

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including 1:1 AP conduction cycle length (milliseconds) during rapid atrial pacing, AP effective refractory period (ERP, in milliseconds), and shortest pre-excited R-R interval during induced atrial fibrillation. Because many patients' initial EPS (1) typically assessed AP ERP with sensed atrial extrastimuli delivered into sinus rhythm at variable intrinsic rates, and (2) did not include induction of atrial fibrillation, the decision was made to focus analysis specifically on those patients for whom 1:1 AP conduction cycle length was measured.

Categorical variables are summarized as proportions and continuous variables summarized as medians with associated range. Comparison of repeated continuous variables was performed with a paired-sample T test. A 2-tailed P value of <0.05 was considered statistically significant. The data collection was performed in accordance with the regulations of the Vanderbilt University Institutional Review Board.

Results

Ten patients met inclusion criteria, undergoing assessment of 1:1 AP conduction cycle length over a single atrioventricular accessory pathway displaying antegrade conduction at 2 distinct EPS in the absence of anti-arrhythmic medication. The cohort was 50% female; 80% of patients had a history of spontaneous, sustained supraventricular tachycardia, but no subject had history of syncope or cardiac arrest. The median age in months at first and follow-up EPS was 0 (range 0–34; median 4 days) and 53 (range 12–123), with median time between assessments 37 months (Table 1). All patients' first EPS consisted of a transesophageal pacing study performed with conscious sedation, with 70% of follow-up EPS being performed under general anesthesia (6/10 invasive, 4/10 transesophageal). Only 1 patient had inducible ART; all patients' APs displayed retrograde conduction at either first or last EPS.

Table 1
Summary of serial electrophysiology study findings (patients $n = 10$).

	Initial EPS	Follow-up EPS
Age (months) (median, range)	0 (0–34)	53 (12–123)
Time between assessments (months) (median, range)	37 (12–123)	
Transesophageal pacing study	100%	40%
Conscious sedation	100%	30%
AP retrograde conduction	80%	90%
Inducible antidromic reciprocating tachycardia	0	10%
Baseline 1:1 AP antegrade conduction (ms) (median, range)	255 (220–420)	275 (220–750)
Additional testing performed on isoproterenol	40%	80%
Induced atrial fibrillation	0	40%
Accessory pathway location:		
Left sided:		
Left lateral	4	
Left posterolateral	1	
Not otherwise specified (non-invasive studies only)	2	
Right sided:		
Right posteroseptal	1	
Not otherwise specified (non-invasive studies only)	2	

Median fastest 1:1 AP conduction was 255 ms at the initial EPS, and there was no significant change at follow-up study (median 275 ms, $P = 0.24$) (Fig. 1). The interval of time between initial and follow-up EPS did not influence this trend (Fig. 2), nor was there any appreciable effect of gender or changes in retrograde AP conduction. After exclusion of a single "outlier" with notably slowed AP conduction at follow-up EPS, there was good correlation between assessments at initial and follow-up EPS ($R = 0.76$, $P = 0.02$). Notably, no patient had clinically significant acceleration of antegrade AP conduction over time: the greatest shortening was observed in a patient with initial 1:1 AP conduction of 420 ms baseline with subsequent decrease to still "slow" 360 ms at follow-up (female, bidirectional left lateral pathway). Three additional patients displayed a decrease of ≤ 20 ms between assessments.

Among the 3 patients with 1:1 AP conduction assessed on isoproterenol at the initial study (median age 5 months), there was a median decrease of 50 ms in shortest cycle length with 1:1 AP conduction; 2 of those 3 patients displayed an even greater response to isoproterenol at their follow-up study. A total of 8 patients underwent testing on isoproterenol at the follow-up study (median age 59 months), with a similar median decrease of 60 ms in shortest cycle length with 1:1 AP conduction.

Discussion

Pediatric electrophysiologists continue to refine both non-invasive and invasive risk stratification strategies to allow identification of those young patients in whom ablation of an accessory pathway (AP) is most appropriate [1]; balancing natural history against procedural risks is complex and often must be performed with only limited supporting data. In some patients these APs display very brisk antegrade conduction characteristics and confer a risk of sudden cardiac death in the event of spontaneous atrial fibrillation. Although ablation is a well-established interventional procedure with a high rate of long-term success [5], some APs are located closely adjacent to the atrioventricular node, where ablation carries a higher risk profile for heart block [6]. Similarly, ablation of APs in younger children may be associated with the potential for inadvertent "collateral damage" to critical cardiac structures such as coronary artery branches [7].

There are times in which an electrophysiology study (EPS) may demonstrate an AP with exclusively antegrade conduction that does not display brisk conduction behavior, and in light of the above considerations, ablation may be deferred [1]. The findings in this retrospective cohort with longitudinal follow-up would suggest that AP antegrade conduction characteristics are indeed relatively static, with no significant difference in fastest 1:1 AP conduction from initial to follow-up study. This observation remained constant independent of the duration of time between studies, nor was there any appreciable effect with changes in retrograde AP conduction.

Importantly, these findings expand similar observations in adults and adolescents to infants and younger children. Klein *et al* reported serial EPS in 29 asymptomatic adults with ventricular pre-excitation, with no significant change over time between initial and follow-up evaluations [3]. In