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## Incidence, clinical, electrophysiological characteristics and outcomes of patients with Wolff-Parkinson-White syndrome and atrial fibrillation

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### ABSTRACT

**Aims and objectives:** Atrial fibrillation (AF) with preexcitation can be life threatening. Our study evaluated the incidence, clinical features, electrophysiologic characteristics and outcomes of patients presenting with AF and fast ventricular rates associated with an antegrade conducting accessory pathway.

**Methods:** Hospital data of patients who had undergone electrophysiology study and radiofrequency ablation for AF and Wolff-Parkinson-White (WPW) syndrome was retrospectively evaluated over 10 years and prospective data was further collected over 1 year. Out of 2876 patients undergoing electrophysiology study, 320 patients had manifest preexcitation on ECG. Forty one patients who had presented with AF and fast ventricular rates were included in the study.

**Results:** Forty one (12.8%) patients out of 320 patients of WPW syndrome patients presented with AF and fast ventricular rates. Mean age of presentation was  $38.5 \pm 12.3$  yrs. Twenty nine (72.5%) were male. Most common presenting features were palpitations, presyncope and syncope. Twenty eight (71.1%) patients were electrically cardioverted on presentation, of which two patients having narrow complex tachycardia, when given adenosine, developed AF and fast ventricular rates and had to be electrically cardioverted. Intravenous amiodarone converted AF to sinus rhythm in 11 (28.9%) patients. Right posteroseptal pathway (33.3%) followed by coronary sinus epicardial pathway (22.9%) were the most commonly located pathways associated with AF. Five (12.2%) patients had multiple pathways. CS diverticulum was seen in 6 (14.7%) patients. Ablation was done during AF in 6 (14.7%) patients. All except one had immediate successful ablation. One patient had a recurrence of preexcitation on follow up and successfully ablated during redo procedure.

**Conclusion:** AF with WPW syndrome is not uncommon. AF is commonly associated with posteriorly located accessory pathways, CS diverticulum and multiple pathways. Radiofrequency ablation has good outcomes.

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### 1. Introduction

Patients with accessory pathways (Wolff-Parkinsons-White (WPW) syndrome) commonly present with orthodromic or antidromic atrioventricular re-entrant tachycardia (AVRT). Atrial fibrillation (AF) can develop in up to one third of patients with

WPW syndrome and can be potentially life threatening if rapid ventricular rate develops as a result of antegrade conduction over accessory pathway [1,2]. Mechanism of genesis of AF in patients with WPW is not clearly understood. Mechanisms postulated are spontaneous degeneration of AVRT to AF, intrinsic atrial muscle vulnerability and effect of accessory pathway (AP) on atrial musculature [3–10]. Our study evaluated incidence, clinical features, electrophysiological characteristics and outcomes of patients presenting with AF having fast ventricular rates associated with an accessory pathway.

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## 2. Method

This is a both retrospective and prospective observational study. Data was collected retrospectively over last 10 year and prospectively for 1 year. Patients who presented with pre-excited AF and in whom complete required clinical and electrophysiological study data was available were included in the study. All patients were subjected to electrophysiology (EP) study according to standard protocol. Arrhythmia induction was done with ventricular and atrial burst pacing or extra stimulus technique using up to 3 extra stimuli with or without isoprenaline. Seven French 4 mm tip ablation catheter was used for ablation. Criteria for successful ablation were loss of preexcitation on atrial stimulation protocol and intravenous bolus of 6 or 12 mg adenosine so as to result in atrio-ventricular (AV) block, decremental VA conduction through AV node during ventricular pacing and non-induction of tachycardia. Electrophysiological features like anterograde conduction, retrograde conduction, localisation of pathway and outcomes of ablation were analysed. Mean duration of follow up was  $4.5 \pm 2.3$  years. Patients who were lost to follow up or had incomplete data were excluded.

## 3. Results

Out of 320 patients of WPW syndrome, 41 patients (12.8%) who presented with pre-excited AF and had complete data and follow up were included in the study.

### 3.1. Clinical characteristics

As shown in Table 1, out of 41 patients, 37 patients presented to hospital with pre-excited AF, 2 patients presented with supraventricular tachycardia (SVT) who after giving adenosine developed pre-excited AF and 2 patients had sustained AF during EP study. Mean age of presentation was  $38.5 \pm 12.3$  years. Twenty nine patients (72.5%) were male. All patients presented with palpitations and presyncope/syncope. Out of 37 patients who presented with pre-excited AF, 24 patients had to be electrically cardioverted because of hemodynamic instability. Thirteen patients were given intravenous amiodarone. Of them 11 patients reverted and other 2 developed hypotension and were electrically cardioverted. Two patients who developed pre-excited AF after intravenous adenosine for supraventricular tachycardia had to be electrically cardioverted. Forty (97.56%) patients had structurally normal heart while only one (2.44%) patient had Ebstein's anomaly with enlarged right atrium.

**Table 1**  
Clinical characteristics.

Characteristics	Number (Percentage)
Male	29(72.5%)
Age	$38.5 \pm 12.3$ years
Palpitations	41 (100%)
Syncope/presyncope	41 (100%)
Hemodynamically unstable on presentation	68.3%
Hemodynamically stable on presentation	31.7%
Patients presenting as pre-excited AF to OPD/ED	37(90.2%)
Patients developing pre-excited AF after adenosine bolus	2(4.9%)
Patients with symptoms & pre-excited AF diagnosed during EP study	2(4.9%)
Electrical cardioversion to achieve sinus rhythm	30(73.2%)
Intravenous Amiodarone to achieve sinus rhythm	11(26.8%)
Intravenous Amiodarone successful in	11 of 13(91.5%)
Structurally normal heart	40(97.6%)

### 3.2. Electrophysiology characteristics

Of the 41 patients, 5 (12.2%) patients had multiple pathways. Two patients had 3 accessory pathways and 3 patients had 2 accessory pathways. Hence there were total of 48 accessory pathways in 41 patients.

Out of 48 number of accessory pathways ablated 16(33.3%) were right postero-septal pathways and 11(26.8%) were coronary sinus (CS) epicardial pathways (Table 2). Out of CS epicardial pathways, 6 were located in CS body (of which 5 had CS diverticulum), 3 pathways were within 1 cm of CS ostium and 2 pathways were located at the middle cardiac vein (MCV) ostium (Table 3).

Out of 48 pathways, 44 (91.7%) had both antegrade and retrograde conduction and 4 (8.3%) patients had antegrade conduction only (Table 4). Seventeen (41.46%) patients developed sustained AF during the procedure (9 during pacing manoeuvres and 8 due to degeneration of AVRT). AF when sustained with hemodynamic compromise required electric cardioversion during the procedure.

Mapping was done using earliest A signal in patients (29 patients (70.73%)) who developed sustained orthodromic AVRT along with earliest V signals during preexcitation. Two (4.88%) patients developed only antidromic AVRT with prior documented AF. If patients developed AF during electrophysiology study then it was electrically cardioverted after giving sedation. Ablation was done in 35 patients either during ongoing AVRT/ventricular pacing or during atrial pacing/sinus rhythm in which preexcitation was apparent. Six (14.63%) patients who developed recurrent AF despite  $\geq 2$  electric cardioversion during the procedure were ablated during pre-excited AF (Table 4). Mapping of annulus was done based on ECG and earliest V was targeted (Fig. 1). Two patients had spontaneous termination of AF during ablation of the pathway (Fig. 2). Two patients successfully terminated after intravenous amiodarone, while rest 2 patients required electric cardioversion. No AF could be induced post ablation on aggressive pacing protocols.

Immediate success was seen in 40(97.5%) out of 41 patients and 47 out of 48 pathways (Table 4). In one patient with right free wall pathway in whom AF and both orthodromic and antidromic AVRT were induced, after multiple and extensive ablations, preexcitation, AF and antidromic AVRT disappeared, but orthodromic AVRT continued to be induced. One patient with CS epicardial pathway had recurrence of preexcitation after 1 month, but was successfully ablated during redo procedure (Table 4). None of the patients on follow up at  $4.5 \pm 2.3$  years had symptoms of palpitations.

## 4. Discussion

Although AVRT is most common in patients with accessory pathway, 10–30% have pre-excited AF as sole manifestation or along with AVRT according to various studies [1,2,5,7]. Our study had 12.8% patients of WPW syndrome presenting as pre-excited AF with fast ventricular rates which compares well with other studies.

According to 2014 ACC/AHA/HRS guidelines for management of patients with AF, pre-excited AF presenting in hemodynamically

**Table 2**  
Location of accessory pathways.

Accessory pathway location	Out of 48 pathways in 41 patients
Right posteroseptal	16(33.3%)
Coronary sinus Epicardial	11(22.9%)
Right posterior/posterolateral	7(14.6%)
Left posterior/posterolateral	6(12.5%)
Left lateral/anterolateral	5(10.4%)
Right anterior/anteroseptal	2(4.2%)
Right free wall	1(2.1%)

**Table 3**

Location of pathways ablated in the coronary sinus.

Epicardial pathway location	Out of 11 pathways
CS body after 1 cm of ostium with CS Diverticulum	5
CS body after 1 cm of ostium without diverticulum	1
Middle cardiac vein ostium	2
Coronary sinus ostium (within 1 cm of ostium)	3

**Table 4**

Electrophysiological characteristics of patients.

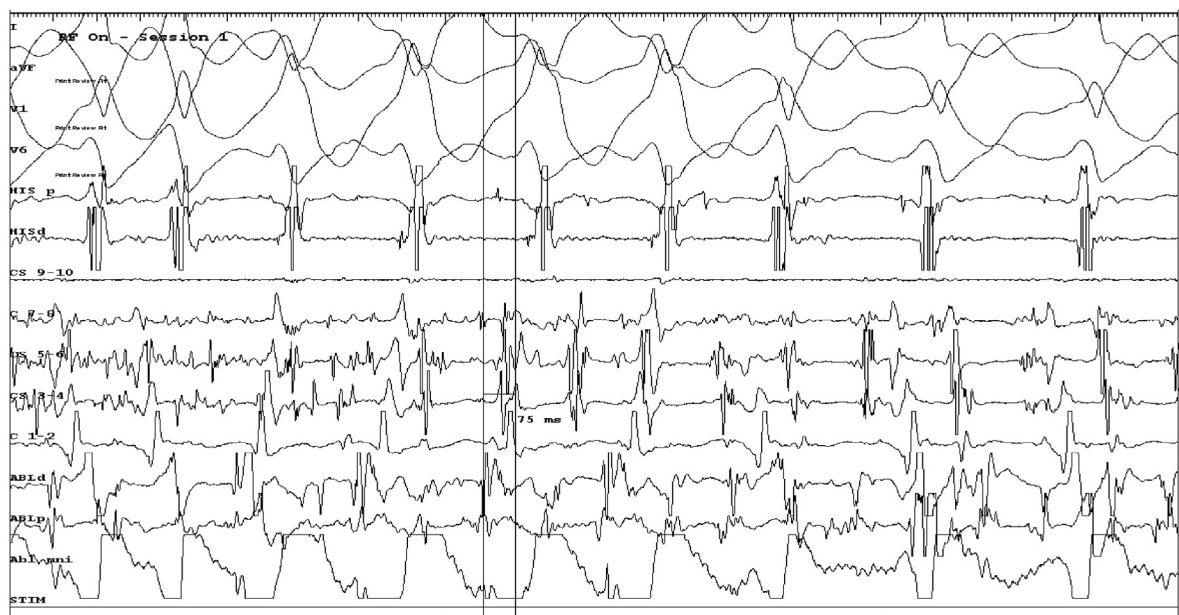
Characteristics	Parameters
Both antegrade and retrograde conduction	44 out of 48 pathways (91.7%)
Antegrade only conduction	4 out of 48 pathways (9.3%)
Orthodromic AVRT	29 out of 41 patients (70.73%)
Orthodromic and antidromic AVRT	5 out of 41 patients (12.2%)
Only antidromic AVRT	2 out of 41 patients (4.88%)
Sustained AF during EP study	17 out of 41 patients (41.46%)
Ablation done during ongoing AF	6(14.63%)
Immediate success	47 out of 48 pathways ablated
Failure	1 out of 48 pathways (2.1%)
Major complications during procedure	0
Recurrence of preexcitation during follow up	1 out of 48 pathways (2.1%)
Recurrence of Symptoms	0

unstable condition should be electrically cardioverted (class I indication) and in stable patients' intravenous procainamide or ibutilide is the drug of choice [11]. Hemodynamically unstable patients were electrically cardioverted. Thirteen patients, who were hemodynamically stable, were given intravenous amiodarone. During amiodarone infusion 2 patients became hemodynamically unstable and had to be electrically cardioverted. Although intravenous amiodarone is class III indication according to ACC/AHA/HRS guideline [11], the same was used due to non-availability of procainamide and ibutilide in India and was found to be effective in 91.5% (11 out of 13) our patients. Intravenous amiodarone was mentioned as class 1 indication for conversion of pre-excited AF to sinus rhythm in 2006 AHA/ACC guideline for treatment of AF [12], but due to reports of development of ventricular fibrillation (VF) in

patients of pre excited AF, class of indication changed from class I to class III in 2011 ACCF/AHA/ESC focused update guideline [13]. However amiodarone is still used for pre-excited AF where intravenous procainamide and ibutilide is still unavailable and in our study it was found to be effective without any degeneration to VF. We do recommend that a defibrillator should be kept ready when giving intravenous amiodarone, as it takes time to act and if hypotension or VF develops, immediate electrical cardioversion can be done.

Adenosine is an effective first line drug for treatment of adult patients with SVT [14]. Adenosine is also known to cause AF due to shortening of refractory period in atrium [15]. Pre-excited AF has rarely developed in patients who were given adenosine for SVT [14,16]. Two patients in our study developed pre-excited AF after giving intravenous bolus adenosine for SVT and had to be electrically cardioverted as they were hemodynamically unstable. So, defibrillators should be kept ready by side of patients who are planned to give adenosine for SVT, as patients with antegrade conducting accessory pathway may develop AF with fast ventricular rate.

In our study most common location of accessory pathway are right postero septal followed by coronary sinus epicardial pathway. This is in contrast to a previous study in which it was shown that there was no relation between occurrence of atrial fibrillation and location of accessory pathway [10]. Postero septal and adjacent coronary sinus region are a complex anatomic structure at crux of heart. It has been shown histologically that Bachmann bundle is continuous anatomically and electrically with muscle fibres of coronary sinus near ligament of Marshall and muscle fibres of coronary sinus connect to right atrium near ostium, thus forming a conduction circuit. This circuit may be a focus for genesis and maintenance of arrhythmia [17]. Posteriorly located pathway, especially epicardial pathway around coronary sinus, are generally broad [17]. Accessory muscle fibres in coronary sinus wrap around the vein or diverticulum. Connection of these muscle fibre over a wide area and abnormally oriented fibre near atrial insertion site may induce inhomogeneous refractoriness in atrial tissue which may play important role in genesis of AF [15]. This hypothesis has



**Fig. 1.** Ablation during AF targeting earliest ventricular signal compared to delta wave in surface ECG in a patient with multiple pathways. Mapping for left lateral pathway (in the mid half) shows local ventricular activation in ablation catheter earlier by 45 msec as compared to pre-excited QRS complex.

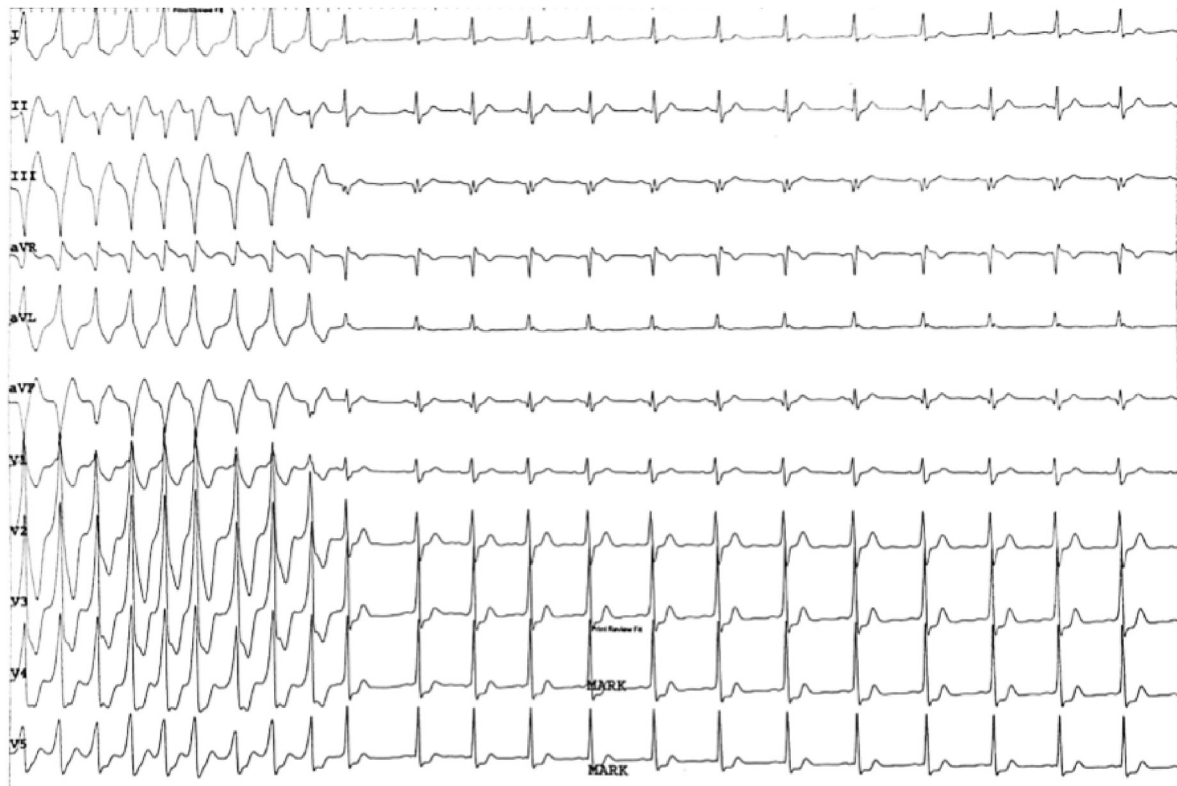


Fig. 2. Ablation during atrial fibrillation in a patient terminated the tachycardia in 10 s. Further there was loss of preexcitation on second ablation.

been suggested by many authors who have also shown presence of abnormal fragmented electrogram near atrial insertion site and their disappearance after ablation. Due to same reason pre-excited AF may be more common in patients with multiple pathways. After successful ablation, AF was not induced in any patients and on follow up no patient had symptoms suggestive of AF. This suggests that genesis of AF is due to pathway itself and successful elimination of pathway is curative of AF in these patients. In study by Dagres et al. [8], patients with age more than 50 years had higher incidence of AF on follow up. In our study the patients were much younger and hence it possibly explains the absence of AF on follow up.

Six patients in our study during EP study developed repeated episodes of AF after electrical cardioversion and these patients were ablated during ongoing AF. Ablation catheter was placed at suspected site of accessory pathway based on ECG localisation and annulus was mapped. Site which had early bipolar ventricular signal relative to delta wave in surface ECG and good unipolar signal was targeted, as described in a study by Kose S. et al. [18]. All 6 cases were successfully ablated during AF. Once in sinus rhythm no patient had inducible AF on pacing even on isoprenaline and adenosine. This suggests that pathway has a role in genesis of AF and successful elimination of pathway is curative of AF in these patients.

Only 1 pathway out of 48 pathways could not be ablated completely, though there was loss of antegrade conduction. This pathway was on the right free wall area. Right free wall pathways present a challenge for ablation due to difficulty in reaching and maintaining stability of catheter [19]. Given that the patient had loss of antegrade conduction, it is likely that the pathway could have been broad and with epicardial extensions. Since the patient on follow up never had complaints it is possible that the patient could have had a late effect of ablation in blocking the retrograde

conduction also. Only one patient required a second procedure. This confirms the high rates of success of treatment of ablation of accessory pathways with RF ablation.

## 5. Conclusion

AF with WPW syndrome is not uncommon. Adenosine when used to treat SVT may degenerate into pre-excited AF with fast ventricular rates and therefore caution needs to be exercised when adenosine is used for treatment of SVT. Intravenous amiodarone has been shown to be effective in hemodynamically stable patients of pre-excited AF with WPW. Patients having WPW and AF have higher association of multiple, posteriorly and epicardial (CS) located accessory pathways. RF ablation has good clinical outcomes. Disappearance of AF after successful elimination of the accessory pathway suggests that pathway itself may play an important role in AF initiation.

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