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A Study of Pre-Excitation Syndrome in Healthy Aircrew

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Nineteen cases of Pre-excitation Syndrome (PES) in aircrew evaluated at Air Force Central Medical Establishment, New Delhi between 1973-82 have been studied. Five cases were ab-initio entrants to Civil and Air Force flying and were considered unfit. 14 cases of PES were noted in serving Air Force aircrew. One case had a single episode of palpitation and another had developed giddiness. The other 12 remained asympto matic. Three cases were diagnosed as Lown-Ganong-Levine Syndrome and 11 had Wolff - Parkinson - White Syndrome. Of the latter, 2 were Type A, 4 Type B, 2 Type C and 3 were Intermittent WPW Syndrome. Ischaemic heart disease was the initial diagnosis in 50% of the cases. 50% of the cases had abnormal ST segment response on stress test. There was no significant arrhythmia in 11 cases. One case was permanently grounded on account of multiple ventricular premature beats. All others were fit for flying.

In 1915, Wilson[17] described certain electrocardiographic features that subsequently came to be grouped under the eponym of Wolff-Parkinson-White Syndrome (WPWS) following the detailed description in 1930 by Wolff, Parkinson and White[18] This syndrome comprises of an electrocardiographic pattern of a shortened PR interval, an initial slurring of the QRS complex, also referred to as the delta wave, and a widened QRS complex. There are secondary ST segment and T wave changes.

One or more accessory pathways between the atria and the ventricles allow for anomalous early activation of part of the ventricle leading to a shortened PR interval and hence the term Pre-excitation Syndrome (PES). A variant of PES is the Lown-Ganong Levine Syndrome[10] (LGLS) which is characterised by a short PR interval but without widening of the QRS complex or its initial distortion.

Since the original description of PES, the predisposition of these patients to a tachyarrhythmia has been well known[6,10,18]. Several studies[1,9] have also shown that secondary repolarisation abnormalities interfere with the interpretation of exercise induced changes. The presence of Q waves in II, III, aVF may simulate myocardial infarction[11]. This has special significance from service point of view in the form of promotional blocks and repeated reviews with its economic repercussions and morale-shattering effect.

Keeping in mind the above problems, a study of all cases of PES evaluated at Air Force Central Medical Establishment (AFCME), New Delhi was undertaken.

Materials and Methods

All cases of PES amongst aircrew evaluated at AF CME, New Delhi between 1973-82 form the subjects of this study. Nominal roll of all cases listed as WPWS, LGLS or PES was made. The medical records of all such cases together with ECG tracings were then studied. All these cases, except one, were examined by the first author when they reported for their periodic reviews or at the time of their first diagnosis. All cases underwent a detailed clinical examination to rule out any organic disease. Full biochemical profile was studied in every case. X-Ray chest, and 14 lead ECG at rest and after double Master's exercise were taken in all cases. Stress test on electrically operated bicycle ergometer or treadmill with an on line digital cardiac monitor system (Avionics) was done in all cases. 24 hours ambulatory monitoring was done in all cases diagnosed after 1977.

Result

A total of 22 cases were diagnosed as PES. Out of this 3 were ground duty officers, whose initial diagnoses were inferior myocardial infarction, inferolateral myocardial infarction and ischaemic heart disease. These being non aircrew have been excluded from this study. Thus, a total of 19 aircrew formed the subjects of this report.

Table I gives the category of cases diagnosed as PES. Two cases reporting for initial issue of civil pilot's licence were noted to have LGLS. They had done 60-100 hours of flying in their local flying club when they came for evaluation. Three cases of PES were noted amongst ab-initio entrants to Air Force flying branch and 14 cases were diagnosed amongst serving Air Force aircrew on routine electrocardiographic evaluation. The 5 ab initio entrants were considered permanently unfit for flying without further investigations and the following details pertain to the 14 serving aircrew of the Air Force.

Table - I

Category of cases diagnosed as PES
(n=19)

i) Ab-initio entrants	
Civil flying	2
Air Force	3
ii) Serving Air Force Aircrew	14

Table II gives the age distribution of the 14 subjects. Mean age was 36.5 yrs.

Table - II

Age at the time of diagnosis
(n=14)

Age (in years)	Numbers
20-30	5
31-40	7
41-50	2

Of these 14 aircrew, 9 were pilots, 3 were navigators and one each flight engineer and flight signaller. Eight of them were transport aircrew flying Dakota or AN-12 aircrafts. There were 4 fighter pilots flying MIGs or SU-7 aircraft and 2 were Canberra crew, one of whom was a pilot and the other a navigator.

Table - III
Hours of flying at the time of diagnosis
(n=14)

Hours	Numbers
850 - 1000	3
1001 - 3000	5
3001 - 5000	5
> 5000	1

Table III gives the flying experience at the time of diagnosis. There were 5 aircrew who had done 1001-3000 hours of flying and 6 had done more than 3000 hours of flying. Thus it can be seen that 11 cases (78.6%) had done more than 1000 hours of flying at the time of diagnosis.

Analysis of the presence of associated diseases revealed that 2 cases had GTT abnormality related to obesity which improved with weight reduction. Two had sustained head injury sometime before the diagnosis of PES. One case was diagnosed as a case of Gilbert's disease after the diagnosis of PES. 8 cases had no associated abnormality.

Table - IV
Clinical details of the cases

Case No.	Symptoms	Initial ECG findings	Initial diagnosis	Final diagnosis
1	Palpitation, pain chest, sweating	T ↓ I, aVL. III, III (R), aVF, aVF (R) T ↑ 2 weeks later	IHD	WPWS - I
2	Nil	Short PR, delta in a VF, T ↓ III aVF.	ECG abnormality	WPWS - C
3	Nil	Multiple VPBs ST ↓ V4-6 after exercise	IHD	WPWS- C
4	Nil	Short PR, delta, QS in III, aVF	WPWS	WPWS - B
5	Nil	ST-T ↓ after exercise in V 4-6	IHD	WPWS - A
6	Nil	Short PR, delta Qr in III, aVF	WPWS-B	WPWS - B
7	Nil	ST-T ↓ after exercise in II, III, aVF, V4 - 6	VRA	LGLS
8	Nil	Short PR, delta	IHD	WPWS - A
9	Giddiness	T ↓ V4-V6 ST - T V4-6 after exercise	IHD	LGLS
10	Nil	Short PR and delta	WPWS - B	WPWS - B
11	Nil	ST - T ↓ V4, 6 WPWS - I on treadmill	WPWS - B	WPWS - B
12	Nil	ST - T ↓ V4-6on exercise	IHD	WPWS - I
13	Nil	Occasional SVE Short PR, no delta	LGLS	LGLS
14	Nil	T ↓ V1-6, on exercise T ↑ T1-6	IHD	WPWS - I

LGLS = LGL Syndrome IHD = Ischaemic Heart Disease WPWA = WPW Syndrome - Type A
WPWS - I = Intermittent WPW Syndrome WPWS - B = WPW Syndrome Type-B
WPWS-C = WPW Syndrome Type-C VRA = Vasoregulatory Abnormality SVE = Supraventricular ectopics

Table IV gives details of symptoms, initial ECG findings and final diagnosis in all the 14 cases. Cases have been arranged in chronological order of their diagnosis. Case 1 was diagnosed the earliest in 1973 and case 14 in 1981. One case (Case 1) had palpitation and sweating associated with pain chest and one case (Case 9) had giddiness. Both were hospitalised and investigated. In view of symptoms and the ECG changes the diagnosis in both the cases was ischaemic heart disease which was later amended to intermittent WPWS (WPWSI) and LGLS respectively. All other cases were asymptomatic and the abnormality was noticed on routine ECG at the time of annual medical examination. Cases 3, 7 and 12 had their ECGs taken earlier, for all other cases the ECG on the day of diagnosis was their first ECG. In case 3, earlier ECGs were normal. In case 7, first ECG had shown short PR interval which was not taken note of. In case 12, the ECG was normal in 1972 but showed changes from 1974 onwards; cognisance of this abnormal finding was taken only in 1980 when the associated ST-T changes alerted the physician to some abnormality. A referral to a specialist centre led to correct diagnosis.

Of the 11 cases of WPWS, type A was present in 2 cases (18.2%) and type B in 4 cases (36.4%) (Fig. 1). In 3 cases (27.3%) the pattern was that of WPWSI (Fig. 2 & Fig. 3) and in 2 cases (18.2%) the WPW pattern was Type-C.

Initial ECG finding was indicative of WPWS in 7 cases (50%) but this diagnosis was made at the onset in only 4 cases (28.5%). Initial diagnosis was IHD in 7 cases (50%) ECG abnormality and Vasoregulatory abnormality were the diagnosis in one case each

Special Investigations

Stress test on treadmill or bicycle ergometer was done in all cases. This was done every time the cases were reviewed at the specialist referral centre. Three cases had undergone a single stress test each. All others had undergone 2 to 6 stress tests (mean 4.1 times). Stress test response was "ischaemic" in 7 cases(50%) (Fig.4 & Fig 5). In those who had multiple stress tests the response varied from a normal response to an "ischaemic" ST response. In only 1 case (7.1%) multiple supraventricular premature beats appeared on stress test.

Ambulatory monitoring was done in 6 cases (42.8%) which showed insignificant ectopic activity in the form of occasional supraventricular complexes, junctional escape beats and a few unifocal ventricular premature beats in 2 cases.

Hypoxia chamber test, tilt table studies and centrifuge run were done in 2 cases with normal response. One case (Case 6) was subjected, at the specialised referral centre, to atrial pacing with a bipolar catheter upto 300 per minute. At this rate the QRS complex became normal but remained aberrant at lower rates. He was given 3 mg intravenous propranolol and paced again. This led to supraventricular tachycardia which was terminated by intravenous digoxin.

Disposal

Five cases (35.7%) were allowed restricted flying at the time of diagnosis. Time taken for awarding restricted flying category in other 8 cases (57.1) varied from 3 months to 24 months (mean 12.8 months). One case (Case 3) was permanently grounded after 5 yrs. as he was mistakenly taken to have ventricular tachycardia (Fig. 6) by the assessing physician. Time taken for awarding permanent flying medical category, restricted or otherwise, varied from 6 months to 42 months (mean 23.1 months.) 12 cases were considered fit for transport flying only. Only one case (Case 12) was fit for all flying and he is currently flying a Mig-21 aircraft.

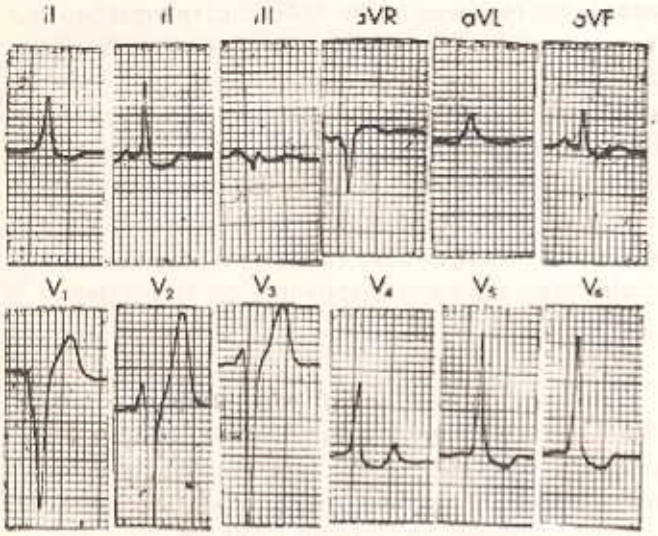

Fig. 1. *Showing short PR interval, delta wave, broad QRS complex and secondary ST-T change. QRS complexes are negative in lead V1 and positive in lead V5 indicating Type B WPW Syndrome.*

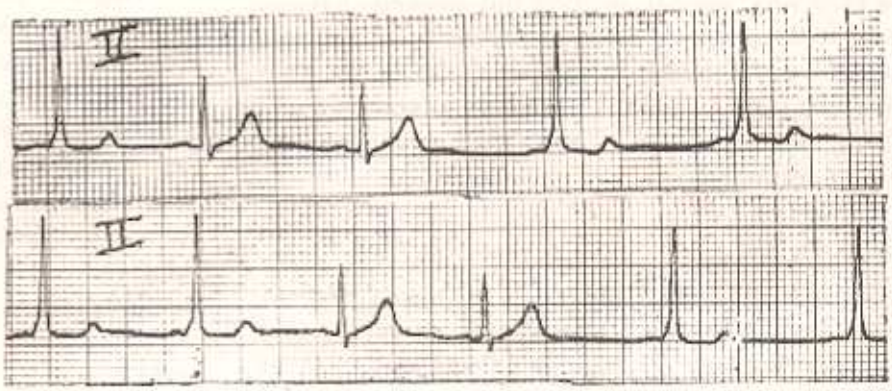

Fig. 2. *The two strips are continuous and show rate dependant WPW Syndrome. As the heart rate slows down WPW complexes are seen to appear.*

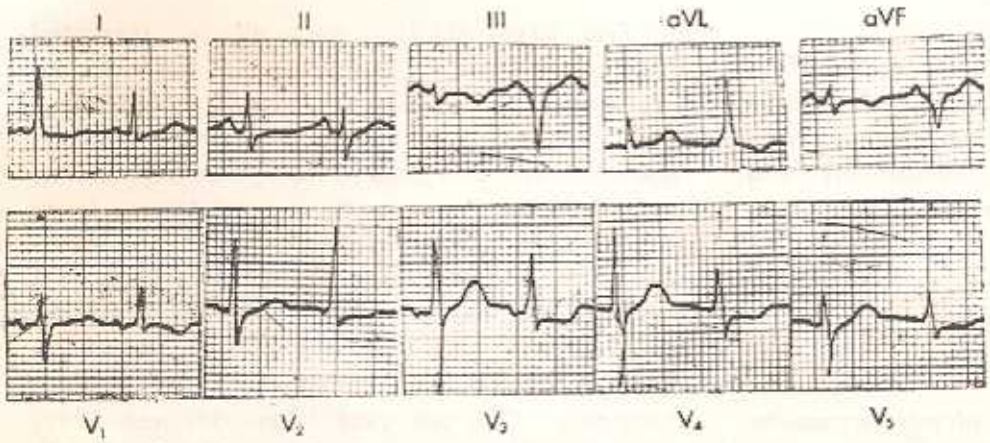

Fig. 3. *Showing intermittent WPW Syndrome. Every normally conducted beat is followed by a pre-excitation complex.*

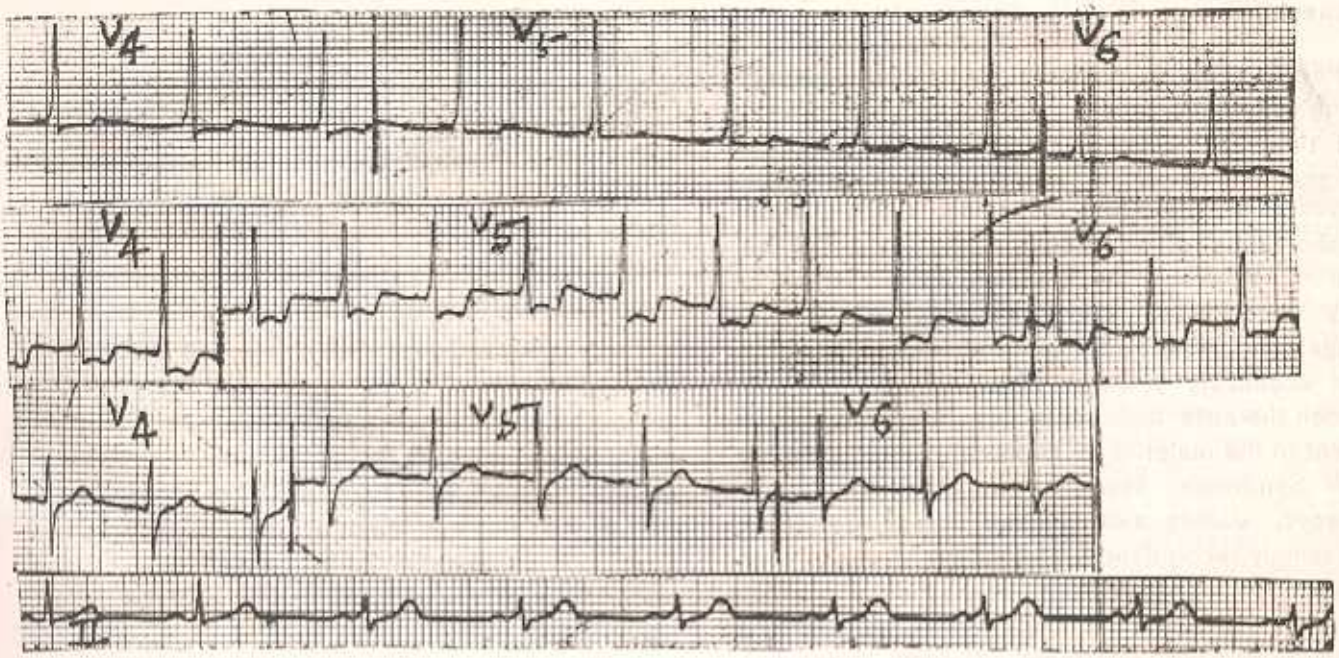

Fig. 4. *Top strip shows WPW complexes with associated secondary ST-T change. Second strip shows marked ST depression of 3 mm after exercise. This is not indicative of ischemia in presence of pre-excitation complex. Bottom strip is lead II of the same patient. Intermittent WPW complexes can be well seen.*

CASE 1

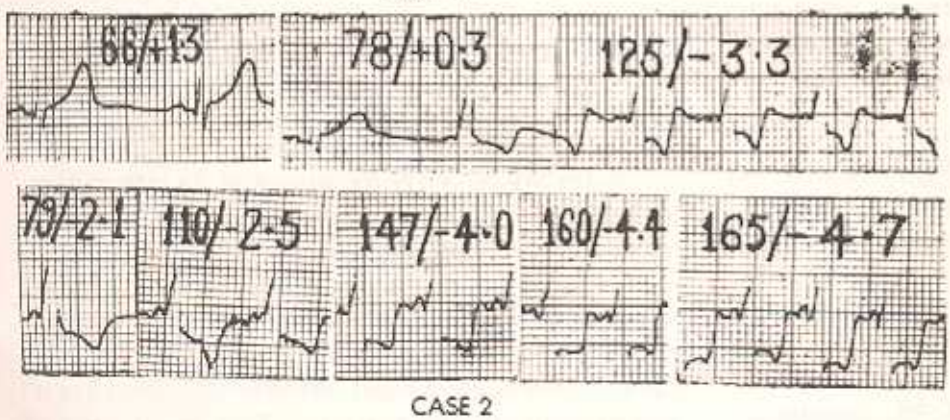

Fig. 5 *Shows gross ST depression on stress testing in 2 cases of WPW Syndrome. Heart rate and the extent of ST depression are mentioned in each strip.*

CASE 2

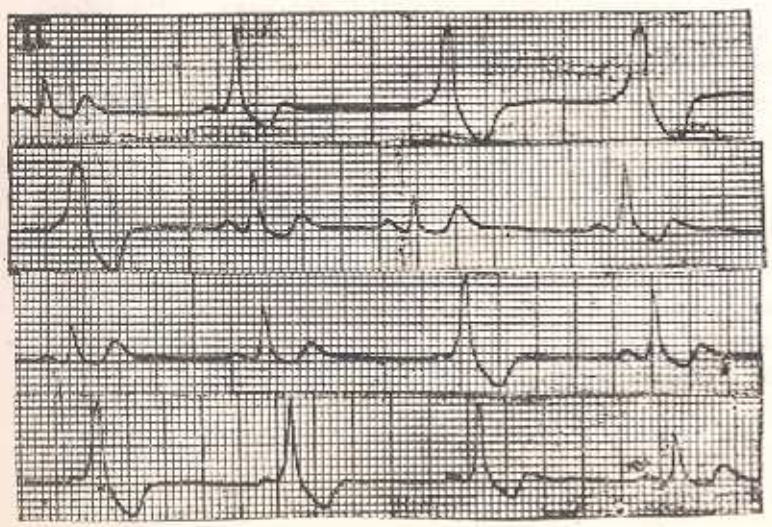

Fig. 6 *This is the continuous tracing of lead II of Case 2. First complex in the top strip is a normally conducted beat. This is followed by a pre-excitation complex. The following three complexes show progressively shorter PR interval and increasing abberrancy of QRS complex due to 'giant delta' waves.*

Discussion

PES is often an incidental electrocardiographic finding without haemodynamic consequences until such time as tachybradyarrhythmia supervenes. Recognition is important since mistaken diagnosis of myocardial infarction, ischaemic heart disease and short runs of ventricular tachycardia may be made[8,14]. Whereas the classical ECG picture is easily recognised, difficulties arise when ECG changes are present only intermittently. An extra-nodal accessory pathway which bridges the gap between the atria and ventricles (Kent Bundle) is present in the majority of classical cases showing WPW Syndrome. However, two other accessory pathways, James and Mahaim fibres are being increasingly recognised[11]. James fibres bypass only the AV node. They consequently produce a short PR interval with normal QRS complexes and are the basis of LGL Syndrome. Mahaim fibres run between the His Bundle or proximal region of bundle branches to the ventricular system. When only one anomalous pathway is present, the surface ECG suggests the type of accessory pathway[3]. However, if more than one accessory pathway are present diagnosis is only possible with detailed electrophysiological studies[6].

The QRS morphology of WPW Syndrome is considered to be a fusion impulse travelling through both the anomalous pathway and normal AV nodal pathway[14]. The duration of QRS varies with the relative extent of conduction through the normal and accessory pathways. This phenomenon was well seen in Case 3 where normal beats, classical WPW fusion beats and bizarre QRS complexes composed entirely of delta waves were well seen. Depending upon the effective refractory period of the two (or more) pathways, spontaneous variation in the cycle length causes the sinus impulse to travel preferentially along the available pathways at a given time[13].

In a study of 128 Air Force personnel who demonstrated WPW pattern, only 17 (13.3%) experienced ectopic rhythm during a follow up period that ranged from 5 to 28 Yrs[2]. In our series, only 1 case (7.1%) had palpitation that too only once, during the long follow up of 10 years. All other cases remained asymptomatic. However, insignificant ectopic activity in the form of occasional supra-ventricular complexes, junctional escape beats and a few unifocal ventricular premature beats were seen in 2 out of 6 of our cases on ambulatory monitoring. This is less than the 40-80% reported by Chung et al[4] or the 43-90% suggested by Gallagher et al[7].

Rosenbaum et al[12] have classified WPW Syndrome into three types, based on the area of pre-excitation. In type A, the pre-excitation area is in the interventricular septum resulting in tall R waves in V1 and V6. Type B WPW Syndrome is characterised by a dominantly negative QRS deflection in V1 and positive in V6. The pre-excitation area in Type B WPW Syndrome is situated in the right lateral ventricle. In Type C, it is situated in the left lateral ventricle resulting in positive QRS in V1 and negative in V6. However this is certainly an oversimplification and with the advent of His Bundle studies, epicardial mapping, atrial pacing and a host of other electrophysiological techniques it has been shown that many accessory pathways may coexist [3,14]. It is not always possible to classify all the cases of WPW syndrome into the three types[6].

A feature of WPW Syndrome is its intermittent tendency[14]. Fluctuations between normal and anomalous conduction may occur from day to day, minute to minute or even from beat to beat. These fluctuations may occur spontaneously or be brought on by certain manoeuvres or drugs. Three of our cases showed intermittent WPWS. In one case it was brought on after exercise. This could indicate a catecholamine-mediated decrease in the refractoriness of the anomalous pathway[16].

ST-T segment depression and flat to inverted T waves at rest and after exercise are very common in PES. The incidence of false positive stress test in this syndrome is thus very high[1,3,9,14,15]. The reported incidence of false positive treadmill test for ischaemic heart disease in patients with pre-excitation has ranged from 27 to 100% [9,15]. In our series 50% had abnormal ST segment response on stress test.

Suggested plan for investigations and disposal of a case of PES in aircrew.

Ab-initio entrants for flying duties showing PES should not be accepted, in view of their susceptibility to a tachyarrhythmia[6].

Asymptomatic serving personnel showing PES on routine ECG for the first time, indicate that pre-excitation (WPW) is intermittent (presuming that previous ECG at the time of intake and subsequently was normal. Such cases would be subjected to detailed clinical examination to rule out any cardiovascular abnormality. ECG at rest and after exercise would be recorded as in other cases. 24 hours ambulatory monitoring should be done to document the type of arrhythmia, if any. Stress testing is not likely to give any additional information except that rate change often normalises conduction[12]. Stress test is also not likely to delineate a subset which is prone to a tachyarrhythmia[15] ST-T responses are not likely to furnish any additional information as these are a part of PES.

Electrophysiological studies are not indicated in asymptomatic individuals and should not be resorted to[5,8]. PES diagnosed in asymptomatic individuals is mostly a benign electrocardiographic anomaly and incidence of tachyarrhythmia is low[5].

If no dangerous arrhythmias are present on ambulatory monitoring, all cases should be considered fit for unrestricted flying and should be reviewed annually.

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