Sport and arrhythmias, Who to ablate?

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There are no known arrhythmias that only occur in athletes

Sport-related sudden cardiac death is far less common in women than in men

Marijon, E. Characteristics and outcome of sudden cardiac arrest during sports in women. *Circ. Arrhythm. Electrophysiol. 2013*

Why treatment/ablation?

- Complaints
- Prevent tachycardiomyopathy
- Prevent sudden cardiac death

Table I Incidence of sudden cardiac death/arrest in young people and athletes according to different reporting systems

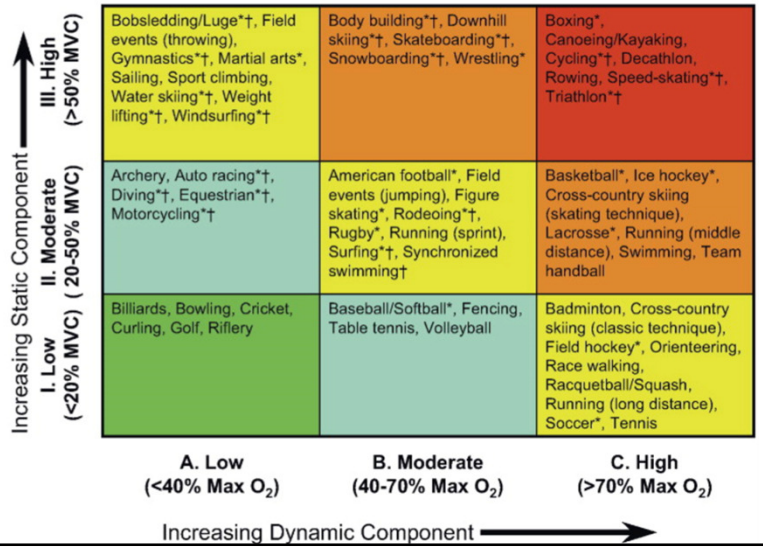
Study population	Ref.	Study design and reporting system	Incidence (person-years)
US Military (age 18–35)	Eckart *et al.*[21]	Retrospective, mandatory	1:9000
Italian Athletes (age 12–35)	Corrado *et al.*[10]	Prospective, mandatory	1:25,000
US Adolescents (age 12–19)	Atkins *et al.*[20]	Prospective, EMS	1:27,000
US Children (age 10–14)	Chugh *et al.*[22]	Prospective, EMS/ Hospitals	1:58,000
US Athletes (age 12–35)	Maron *et al.*[19]	Retrospective, public media reports	1:160,000

EMS, emergency medical service.

Why treatment/ablation?

- Complaints
- Prevent tachycardiomyopathy

Bethesda classification of sports



Keywords

- **Static** component is related to the estimated percent of maximal voluntary contraction (MVC) reached and results in an increasing blood pressure load
- **Dynamic** component is defined in terms of the estimated percent of maximal oxygen uptake ($MaxO_2$) achieved and results in an increasing cardiac output.
  - cardiovascular demands (cardiac output and blood pressure) green, blue and red, yellow and orange depict cardiovascular different level of demands.

Definitions

- Athletes were defined as those engaged in
  - Class IB, IIA or higher activities
  - ≥ 3 h/week during > 10 years or ≥ 1500 hours after the age of 14 years
- Those engaged in Class IA activities were not considered athletes

Definitions

- Endurance athletes were defined as
  - those who performed regular endurance sport activity (cycling, jogging, swimming, soccer, rowing, etc.) for at least 3 hours/week for at least the 10 years immediately preceding the arrhythmia diagnosis
  - i.e. a lifetime sport practice of at least 1500 h

Definitions

- Competitive sports are generally regarded as those sports in which a premium is placed on winning and to which end athletes are driven to push themselves to exhaustion during sport and training

Arrhythmias in Structurally Normal Hearts

- Bradyarrhythmias
- Supraventricular Arrhythmias
- Idiopathic Ventricular Tachyacardia

Sudden Death and Ventricular Arrhythmias in (young) Athletes

- Hypertrophic cardiomyopathy
- ARVC
- Other conditions
  - Channelopathies: Brugada S, LQTS, SQTS, CPVT, early repolarization S
  - Non-compaction cardiomyopathy
  - Anomalous coronary arteries
  - Commotio cordis
  - Myocarditis

Bradyarrhythmias

Table 1. Treatment and Restrictions from Athletics for Players with Bradyarrhythmias (Based on the 36th Bethesda Conference)

Condition	Symptoms	Diagnosis	Treatment Options	Competitive Athletics
1st degree HB	None	EKG	None	No restrictions
Wenckebach	None	Monitor, EKG	None	No restrictions
Wenckebach	LH, syncope	Monitor, EKG	PPM	No bodily collision if PPM present
Mobitz II or CHB	None	Monitor, EKG	PPM	No bodily collision
Mobitz II or CHB	LH, syncope	Monitor, EKG	PPM	No bodily collision

Adapted from Link MS, Wang PJ, Estes NAM. Cardiac Arrhythmias and Electrophysiologic Observations in the Athlete. Lippincott Williams & Wilkins, 1998, with permission.
HB = heart block; EKG = electrocardiogram; LH = lightheadedness; PPM = permanent pacemaker; CHB = complete heart block.

Supraventricular tachycardias

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Table 2. Evaluation and Treatment of Supraventricular Arrhythmias

Condition	Symptoms	EKG	Diagnosis	Treatment options	Competitive athletics
AVNRT	Palpitations, LH	NL	Monitor, EPS	BB, digoxin, Ca ch ant, RFA	After 3–6 months of a symptom free period
WPW	Asymptomatic	Short PR, delta waves	EKG, EPS	No therapy, RFA if rapidly conduction BPT	In order to compete athletes should undergo an EPS to stratify risk of SCD
WPW	Palpitations, LH, syncope	Short PR, delta waves	EKG, EPS	RFA, antiarrhythmics	After 1–2 months of a symptom free period
Atrial fibrillation	Palpitations	Often NL	Monitor	RFA, antiarrhythmics, rate control,	If warfarin is used for anticoagulation sports with bodily contact should be avoided.
Atrial flutter	Palpitations	Often NL	Monitor	RFA	After 1–2 months of a symptom free period
APC	Palpitations	Often NL	Monitor	Reassure, BB is disabling symptoms	No restrictions

Recommendations for participating in competitive athletics are based on the 36th Bethesda Conference on Recommendations for Determining Eligibility for Competition in Athletes with Cardiovascular Abnormalities.
Adapted from Link MS, Wang PJ, Estes NAM. Cardiac Arrhythmias and Electrophysiologic Observations in the Athlete. Lippincott Williams & Wilkins, 1998, with permission.
EKG = electrocardiogram; AVNRT = atrioventricular reentrant tachycardia; LH = lightheadedness; NL = normal; EPS = electrophysiologic study; BB = beta-blockers; Ca ch ant = calcium channel antagonists; RFA = radiofrequency ablation; WPW = Wolff-Parkinson-White syndrome; SCD = sudden cardiac death.

Atrial flutter and sport

Radiofrequency ablation is preferable to antiarrhythmic agents in individuals with atrial flutter because of the high likelihood of cure and the low risk of the procedure

Zipes DP, Ackerman MJ, Estes III NAM, Grant AO, Myerburg RJ, Van Hare G: Task Force 7: Arrhythmias. 36th Bethesda Conference: Eligibility Recommendations for Competitive AthletesWith Cardiovascular Abnormalities. J Am Coll Cardiol 2005;45:43–52.

Supraventricular tachycardias and sport

- AVNRT
- AVRT
- Atrial Tachycardia

- Not more common in the athlete
- Initial treatment betablockers and calcium antagonist
- Ablation preferred

Pelliccia A, Fagard R, Bjornstad HH, et al Eur Heart J 2005;26:1422–1445

Zipes DP, Ackerman MJ, Estes III NAM, Grant AO, Myerburg RJ, Van Hare G: Task Force 7: Arrhythmias. 36th Bethesda Conference: Eligibility Recommendations for Competitive AthletesWith Cardiovascular Abnormalities. J Am Coll Cardiol 2005;45:43–52.

Atrial fibrillation and sport

Table I Characteristics of the included studies

Author/publication year	Type of athletes	Age (years) mean ± SD (athletes vs. controls)	Men (%)	Cases of AF/athletes	Cases of AF/controls
Karjalainen *et al.*[8]	Orienteers	48 ± 6 (46 ± 7 vs. 50 ± 5)	100	12/228 (5%)	2/212 (0.9%)
Heidbuchel *et al.*[9]	Mixed sports	55 ± 10 (53 ± 9 vs. 60 ± 10)	88	25/31 (81%)	50/106 (48%)
Elosua *et al.*[10]	Mixed sports	43 ± 12 (NA)	69	16/31 (51%)	35/129 (27%)
Molina *et al.*[11]	Marathon runners	45 ± 10 (39 ± 9 vs. 50 ± 13)	100	9/183 (5%)	2/290 (0.7%)
Mont *et al.*[12]	Mixed sports	48 ± 10 (NA)	100	83/120 (69%)	24/96 (25%)
Baldesberger *et al.*[13]	Cyclists	67 ± 7 (67 ± 7 vs. 67 ± 6)	100	6/62 (10%)	0/62 (0%)
Total studies ($n = 6$)	Mixed sports	51 ± 9	93	151/655 (23%)	113/895 (12.5%)

AF, atrial fibrillation, NA, not available, *n*, number.

Abdulla and Nielsen 2009

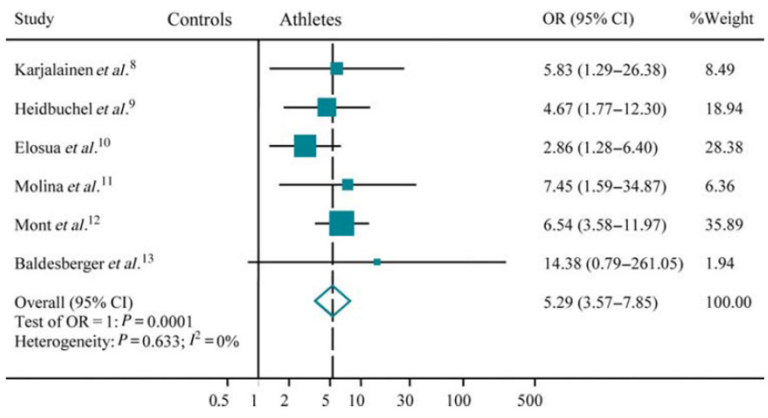
AF in athletes and normal population

Differences between atrial fibrillation in athletes and the normal population

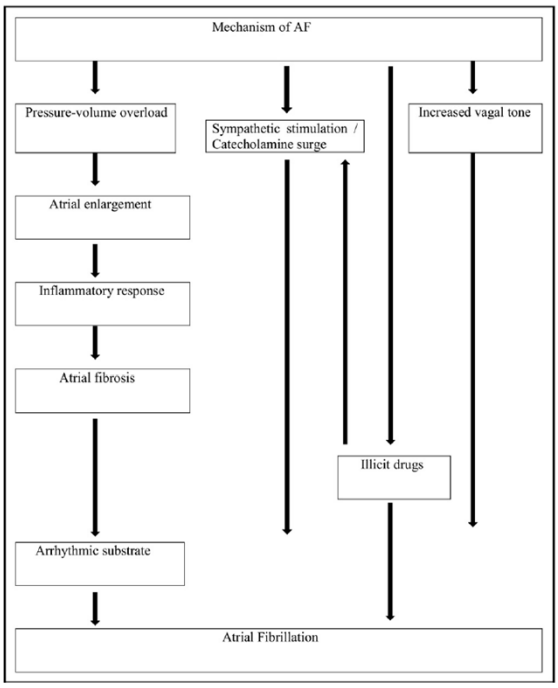
	Athletes	Nonathletes
Type	Vagal mediated	Adrenergic mediated
Presentation	Usually intermittent, paroxysmal	Paroxysmal, persistent, or permanent
Epidemiology	Variable, prevalence 0.2% to 60%	Mean prevalence of 0.5% to 5% (higher in older age group)
Clinical features	Palpitations are more common, chest discomfort, shortness of breath, diaphoresis, syncope	Palpitations, chest discomfort, shortness of breath, diaphoresis, syncope
Causes	Autonomic changes, cardiac adaptability, inflammation, fluid shifts, illicit drugs	Hypertension, valvular heart disease, myocardial infarction, pulmonary disease, hyperthyroidism, alcohol
Treatments	Sports abstinence, antiarrhythmic drugs, antiplatelet, ablation, anticoagulation (not preferred)	Rate-control medications, antiarrhythmic drugs, anticoagulation, ablation
Prognosis	Favorable for lone AF in the absence of underlying structural heart disease or risk factors	Not very favorable; risk for stroke and heart failure

The typical clinical profile of sport-related AF or atrial flutter is a middle-aged man (in his forties or fifties) who has been involved in regular endurance sport practice since his youth (soccer, cycling, jogging, and swimming), and is still active.

Atrial fibrillation and sport



Abdulla and Nielsen 2009



Treatment of AF

- Does not differ greatly in athletes
  - Beta blockers
  - Flecainide, Propafenon
  - Dronedarone, amiodarone
  - Sotalol
  - Disopyramide
  - Ablation

Atrial fibrillation

- Asymptomatic AF patients can participate in any competitive sport
  - in the absence of structural heart disease
  - provided they maintain a ventricular rate that increases and slows appropriately and comparable to that of a normal sinus response in relation to the level of activity, while receiving no therapy or therapy with AV nodal-blocking drugs.

36th Bethesda Conference

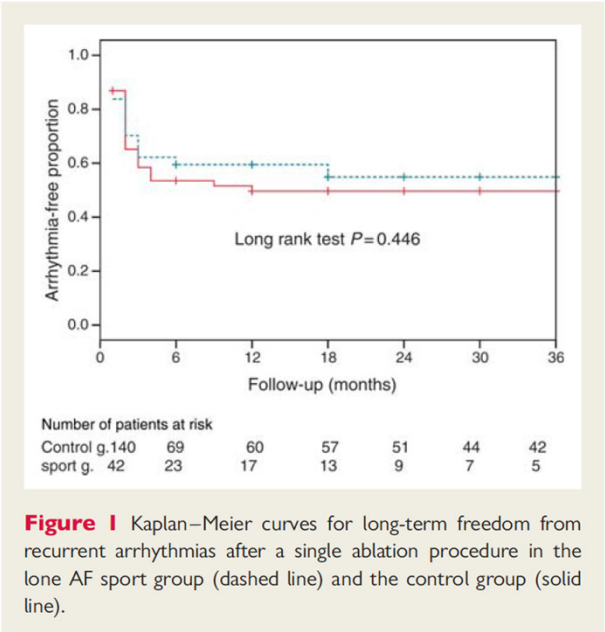


Figure 1 Kaplan–Meier curves for long-term freedom from recurrent arrhythmias after a single ablation procedure in the lone AF sport group (dashed line) and the control group (solid line).

Calvo et al, Europace 2010;

Table 3 Relationship between each baseline variable and arrhythmia recurrence after a single ablation procedure

	Hazard ratio (95% CI)	*P*-value
Age (years)	1.004 (0.983–1.025)	0.742
Male gender	1.048 (0.598–1.838)	0.869
Hypertension	1.181 (0.743–1.877)	0.482
Paroxysmal AF	0.535 (0.344–0.831)	0.005
Structural heart disease	0.931 (0.501–1.729)	0.821
AF duration (months)	1.00 (0.997–1.003)	0.940
LAD (mm)	1.057 (1.013–1.104)	0.011
LVEDD (mm)	1.014 (0.962–1.069)	0.609
LVESD (mm)	1.036 (0.997–1.077)	0.070
LVEF (%)	0.974 (0.953–0.996)	0.020
Sport practice	0.821 (0.475–1.419)	0.479

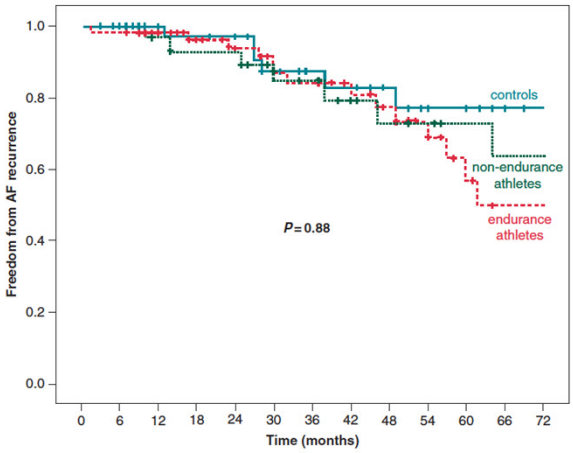
AF, atrial fibrillation; LAD, left atrial anteroposterior diameter; LVEDD, left ventricle end-diastolic diameter; LVESD, left ventricle end-systolic diameter; LVEF, left ventricle ejection fraction.

Calvo et al, Europace 2010;

Table 4 Final model of the Cox regression for arrhythmia recurrence after a single ablation procedure

	Hazard ratio (95% CI)	*P*-value
AF		
Paroxysmal	1 (—)	—
Persistent	1.819 (0.990–3.340)	0.054
Long-standing	2.297 (1.090–4.839)	0.029
LAD (mm)	1.069 (1.018–1.122)	0.007

Calvo et al, Europace 2010;



Number of patients at risk

controls	41	36	32	20	14	10
endurance	59	55	42	33	20	10
non-endurance	35	28	25	18	10	8

Figure 2 Final outcome after multiple ablations, on or off drugs. AF, atrial fibrillation. *P* value: log-rank *P* for 5-year follow-up, endurance athletes vs. non-endurance athletes vs. controls.

Koopman et al, Europace 2011;

Table 3 Univariate Cox regression analysis, predictors for recurrence of atrial fibrillation on or off drugs after a single ablation procedure

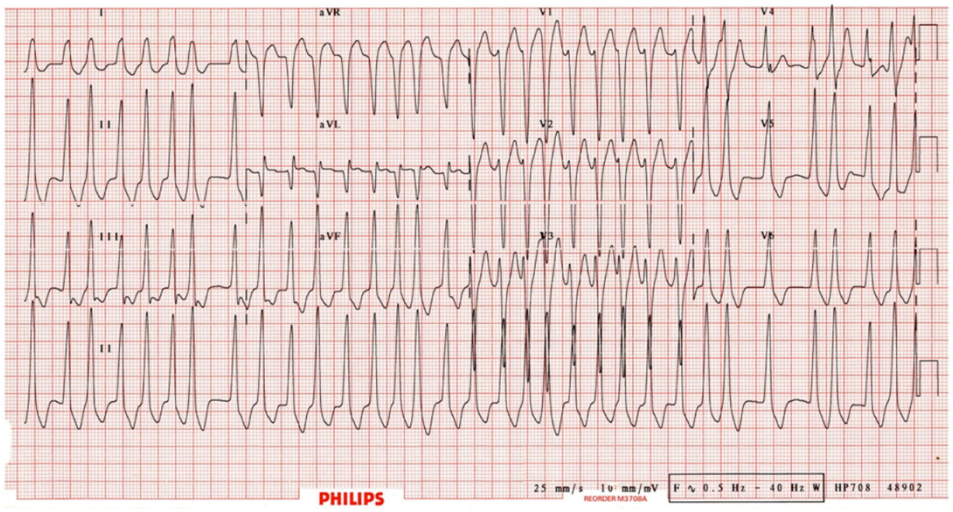
Covariate	Hazard ratio	*P* value
Age (years)	0.987 (0.959–1.016)	0.39
Male gender	1.586 (0.832–3.025)	0.16
Persistent AF	1.072 (0.533–2.156)	0.84
AF duration (years)	1.012 (0.974–1.053)	0.54
Echocardiography		
LAD	1.006 (0.972–1.040)	0.74
LVEDD	1.029 (0.977–1.084)	0.28
LVEF	0.973 (0.941–1.006)	0.11
AHT	0.874 (0.513–1.490)	0.62
Lone AF	1.046 (0.654–1.671)	0.85
Sports practice		
Athlete	0.858 (0.516–1.427)	0.56
Sports type		
Non-endurance	0.999 (0.552–1.807)	1.00
Endurance	0.771 (0.457–1.355)	0.37
Lifetime (hours)	1.000 (1.000–1.000)	0.25
Since 14 years of age (hours/week)	0.976 (0.936–1.017)	0.25
After first ablation (hours/week)	0.967 (0.903–1.037)	0.35
PVI		
Ipsilateral circumferential	1.758 (0.950–3.253)	0.07
Additional lines	1.144 (0.626–2.091)	0.66

AF, atrial fibrillation; LAD, left atrial diameter; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; SHD, structural heart disease; AHT, arterial hypertension; and PVI, pulmonary vein isolation.
Data are expressed as hazard ratio and confidence interval (CI)

Koopman et al, Europace 2011;

WPW syndrome and sport

- Not more common in the athlete
- Athletes with WPW may be at higher risk for sudden death due to the high sympathetic drive seen with competition and with training
- 1% of deaths in a long-term registry of sudden death in athletes was attributed to WPW



WPW syndrome and sport

- Bethesda conference: Risk stratification with an EP study is advisable in asymptomatic athletes engaged in moderate- to high-level competitive sports
- ESC: all athletes with WPW undergo comprehensive risk assessment including an EP study.

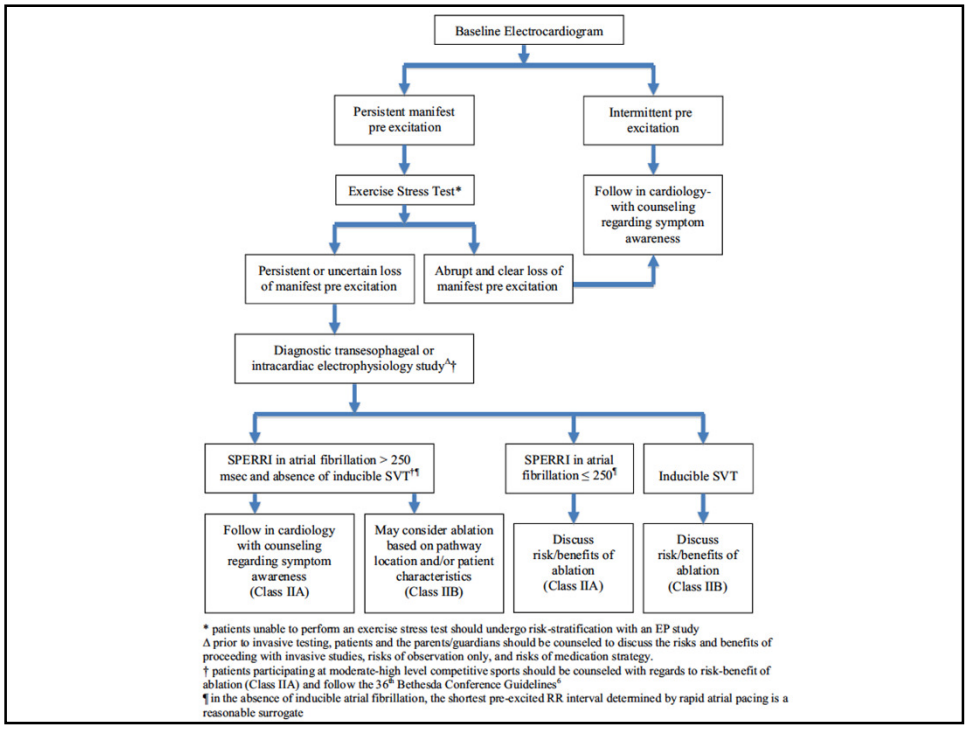
Bypass tract benign or malignant?

The non invasive parameters of a presumed long refractory period of bypass tract (>250ms) include:

1. Intermittent pre-excitation
2. Disappearance of pre-excitation during exercise
3. Disappearance of pre-excitation with procainamide

WPW syndrome, sport and EPS

- Shortest Preexcited R-R Interval (SPERRI) <240 ms in AF or <220 ms during stress or isoprotenerol
- Anterograde effective refractory period of accessory pathway < 240ms at baseline (without isoprotenerol)
- Presence of multiple accessory pathways
- Easily inducible AF
- M. Ebstein
- Familial WPW
- Male gender
- Young age



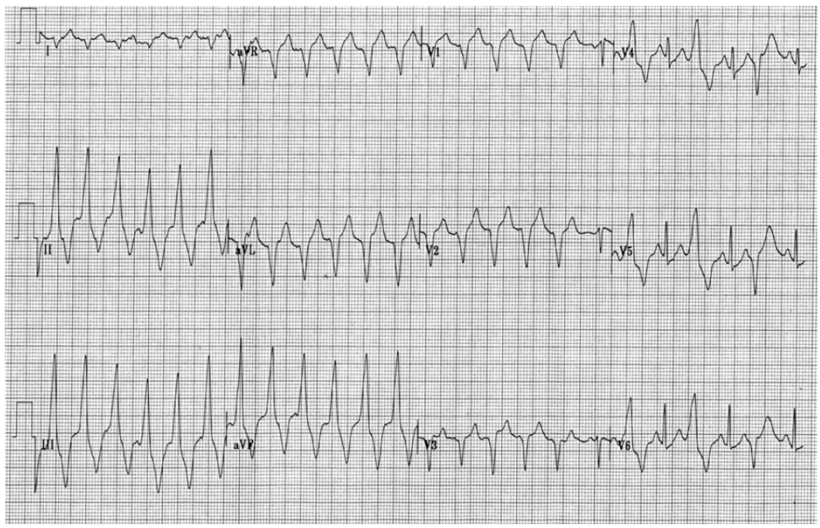
WPW syndrome and sport

Radiofrequency ablation for the symptomatic athlete with WPW is recommended

Idiopathic Ventricular Tachycardia and Sport

- The 2 most common cardiac regions for idiopathic VT are the right ventricular outflow tract and the left posterior fascicle
- Both of these VT can be triggered by exercise and both these VT are readily curable with ablation
- Both VT are also adenosine and verapamil sensitive

RVOT VT



Belhassen VT

Idiopathic Ventricular Tachycardia and Sport

- In individuals with idiopathic ventricular tachycardias strong consideration should be given to ablation as the ablation is curative and of relatively low risk

- Zipes DP, Ackerman MJ, Estes III NAM, Grant AO, Myerburg RJ, Van Hare G: Task Force 7: Arrhythmias. 36th Bethesda Conference: Eligibility Recommendations for Competitive AthletesWith Cardiovascular Abnormalities. J Am Coll Cardiol 2005;45:43–52
- Pelliccia A, Fagard R, Bjornstad HH, et al Eur Heart J 2005;26:1422–1445.

Conclusions: sport and arrhythmias: who to ablate?

	Indication	Success	Risk
Aflutter	++	+++	--
AVNRT	++	+++	-
WPW	++	++	+/-
AVRT	++	++	+/-
Atrial fibrillation	+/-	+	+/-
VT (RVOT/fascicular)	+/-	+	+/-