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REVIEW

Cardiological contraindications in sports

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Abstract

Sudden death in sports is caused in most cases by heart disease. The aim of pre-participation screening is to identify individuals who require specific treatment to continue the sport or who should cease the practice of sport. Current scientific evidence is based on expert recommendations that in some cases are controversial and impractical. This review aims to give an updated approach and pragmatic recommendations in athletes with heart disease.

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PALABRAS CLAVE

Cribado pre-
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Contraindicaciones cardiológicas para la práctica deportiva

Resumen

La muerte súbita en el deporte está causada en la mayoría de ocasiones por enfermedades cardíacas. El objetivo del cribado pre-participativo es poder identificar a los individuos que requieran un tratamiento específico para continuar el deporte o el cese de la práctica deportiva. La evidencia científica actual se basa en recomendaciones de expertos que en algunos casos son controvertidas y en ocasiones poco prácticas. Esta revisión tiene como objetivo dar un enfoque actualizado y pragmático de las recomendaciones en los deportistas con cardiopatía.

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Introduction

The cardiovascular benefits of moderate exercise are well established.¹ However, exercise can occasionally cause sudden cardiac death in athletes with heart disease base.² In this context, sport disqualification of affected individuals has proven to be a useful strategy in the only study with this objective.³

The recent update of the Bethesda conference⁴ provides recommendations C-level (expert opinion) for competitive athletes, but in some points differs from the European cardiomyopathies and valvular recommendations,⁵ arrhythmias and channelopathies,^{6,7} and congenital heart disease.⁸ The group of sports cardiology at the European Society of Cardiology⁹ included recommendations for non-competitive athletes, i.e.: those who practice recreational sport and physical activity in general, recommendations that had not been previously incorporated; also, in this publication a change of practical value is added at the time of giving a medical recommendation for conducting sports, changing the dynamic component of classification Mitchell¹⁰ (Table 1) by the percentage of heart rate (HR) maximum obtained in a stress test analysis of respiratory gases; or the equivalent in the Borg scale of perceived exertion (Table 2).

Definitions

The type of physical activity is of particular importance to the recommendation in the intensity of exercise. Here are some definitions to distinguish amongst different types of physical activity in which there is international consensus.

Physical activity

Any bodily movement produced by muscles contraction that increases the metabolic rate above resting level. Moderate activity is defined as an activity between 3-6 METs and vigorous when it is > 6 METs.⁸

Regular exercise

It is physical activity planned, structured and repetitive; which is performed for more than 30 min at least 3 days a week for the last 3 months with a moderate intensity; and it aims to maintain or improve physical fitness.¹¹

Recreational sport

Physical activities without the need to compete or that have not a greater intensity than desired by the partici-

Table 1 Classification of Mitchell for sports

III. Static high	Martial arts ^a	Bodybuilding ^{a,b}	Boxing ^a	
	Climbing ^{a,b}	Alpine skiing ^{a,b}	Cycling ^{a,b}	
	Artistic gymnastics ^{a,b}	Snowboard ^{a,b}	Speed-skating ^{a,b}	
	Weightlifting	Fight ^a	Rowing	
	Sky jump ^{a,b}		Triathlon ^{a,b}	
	Candle		Waterpolo ^{a,b}	
	Windsurfing ^{a,b}			
	Motorsports ^{a,b}	Athletics-speed	Running (middle distance)	
	Diving ^{a,b}	Filed events (jumping)	Basketball ^a	
	Riding ^{a,b}	Fencing	Handball ^a	
II. Static moderate	Motorcycling ^{a,b}	Football ^a	Ice hockey ^a	
	Archery	Rhythmic gymnastics	Hockey skates ^a	
	Speed boat ^{a,b}	Synchronized swimming ^b	Swimming	
	Angling ^b	Skating ^a	Modern pentathlon	
	Polo ^b	Rugby ^a	Tennis	
		Surf ^{a,b}	Paddle	
		Caving ^b		
	I. Static low	Billiards	Baseball	Running (long distance)
		Bowling	Softball	Badminton
		Golf	Ball	Cross country skiing ^{a,b}
Pitch and putt		Double tennis	Football ^a	
Boules		Table tennis	Hockey grass ^a	
Olympic shot		Volleyball	Orienteering	
Yoga		Hunting		
A. Dynamic low		B. Dynamic moderate	C. Dynamic high	

The dynamic component is calculated at the estimated maximum rate of oxygen consumption (VO₂ max; A: < 50% B: 50-75% C: > 75%); and the static component is related to the estimated percentage of maximum voluntary contraction reached (MVC; I: < 10% II: 10-30, III: > 30%).

^a Contact sports with risk of body collision.

^b Sports life-threatening if syncope.

Table 2 Borg Scale

Borg	Intensity	Sweat	Speaks	FC maximum
5	Light	Do not	Yes, normal	40-60%
6	Moderate	Little sweat	Phrases	60-75%
7	Heavy	Sweat	Words	75-90%
9	Very heavy	Very sweated	Do not	> 90%
10	STOP			

Table 3 Recommendations cardiomyopathies^{9,13}

Cardiomyopathy	Yellow (Y)	Red (R)
LV hypertrophy	IVS or PPD 13 to 15 mm	IVS or PPD > 15 mm or diagnosis of hypertrophic cardiomyopathy
LV function	LVEF 30-50%	LVEF < 30%
Coronary heart disease	If there is risk criteria ^a	
Arrhythmogenic RV cardiomyopathy	Asymptomatic ^b	Symptom
Myocarditis-pericarditis		Contraindicated acute phase ^c

IVS: interventricular septum; LV: left ventricle; LVEF: left ventricle ejection fraction; PPD: posterior wall in diastole; RV: right ventricle. Yellow (Y): IA Mitchell competitive sport; recreational sport: low-moderate static component and intensity < 75%FC maximum or < 6 Borg Scale.

Red (R): competitive sport is contraindicated; recreational sport: under static component and intensity < 60%FC maximum or < 5 Borg Scale.

^a CHD risk criteria: 1) LVEF < 50%; 2) symptoms; 3) ventricular arrhythmia or ischemia in the stress test; 4) significant stenosis coronary artery; 5) incomplete surgical or percutaneous revascularization.

^b Symptoms: pre-syncope, syncope, resuscitated sudden death, malignant ventricular arrhythmia in Holter 24 hours or stress test.

^c Can perform physical activity after normalized: laboratory markers, ECG, echocardiography (LVEF > 55% and no pericardial effusion), Holter (no arrhythmia).

part. The activity or sport can be organized or informal, and can be spontaneous or structured for competition among participants or teams. However, any participant may stop participating or may decrease the intensity of his participation at any time, without pressure to continue.⁸

Competitive sport

Organized sport, competitive, and in which physical activities are governed by rules to keep a clean game. There is pressure to train or play at a high intensity regardless of whether that intensity is required or recommended for the participant. The source of that pressure may be the athlete himself, teammates, coaches or spectators.⁸

Elite

Competitive athlete training over 6 hours a week who regularly competes at regional, national or international level.¹²

Recommendations

The objective of this review is to summarize the main anomalies and heart disease that can be found in athletes and aims to give a recommendation and general pattern of steps to follow in the case of recommendation of the car-

diological aptitude for sports taking the main groups of heart disease, i.e.: cardiomyopathies (table 3), valvular heart and aorta (table 4), arrhythmias and channelopathies (table 5), and congenital heart disease (table 6). For each of the alterations a recommended intensity is given depending on the type of recreational or competitive sport exercise. In order to simplify this indication a red color was granted when competitive sport is contraindicated and recreational sport is permitted if a low static component (Mitchell I) and is carried out at a lower intensity than 60% maximum heart rate or less than 5 Borg Scale; a yellow color is granted only when the competitive sport is allowed in sports classification of Mitchell IA (i.e.: golf, bowling) and recreational sport is permitted if it is a low-moderate static component (Mitchell I and II) and carried out at a lower intensity than 75% maximum heart rate or less than 6 Borg Scale. However, it is noteworthy that the decision should always be individualized and customized according to the severity of the disease, comorbidities of the subject, mode and sport that is practiced and, importantly, personal environment of the subject.

Play again

Table 7 shows the recommendations on the procedure to return to competitive sport ("play again") after the differ-

Table 4 Recommendations and aortic valve disease^{9,14-16}

Aortic valve disease	Yellow (Y)	Red (R)
Aortic stenosis or pulmonary	Mild-moderate: maximum flow velocity 2.6-4.0 m/s	Moderate-severe: maximum flow rate > 4.0 m/s. Assess surgery
Mitral stenosis	Mitral area 1.0-1.5 cm ² and maximum effort PSAP < 50 mmHg	Mitral valve area < 1.0 cm ² or PSAP maximum effort > 50 mmHg. Rate surgery
Aortic or mitral insufficiency	Moderate-severe failure, LVDD < 63 mm and LVEF > 55%	Moderate-severe failure, LVDD > 63 mm or LVEF < 55% Assess surgery
Bicuspid aortic valve. Normo-functioning: all sports	Mild-moderate regurgitation or stenosis	Moderate-severe regurgitation or stenosis. Assess surgery
Mitral valve prolapse	If you have any risk criterion ^a	
Dilated aortic root	40-45 mm	> 45 mm
Aortic coarctation	Z-score > 3 or arm-leg gradient > 20 mmHg, or hypertension effort	

LVDD: left ventricle diastolic diameter; LVEF: left ventricle ejection fraction; PSAP: systolic pulmonary artery systolic pressure.

Yellow (Y): IA Mitchell competitive sport; recreational sport: low-moderate static component and intensity < 75%FC maximum or < 6 Borg Scale.

Red (R): competitive sport is contraindicated; recreational sport: under static component and intensity < 60%FC maximum or < 5 Borg Scale.

^a Criteria mitral valve prolapse risk syncope, ventricular arrhythmia, family history of sudden death, severe mitral regurgitation.

Table 5 Recommendations arrhythmias and channelopathies^{6,7,17,18}

Arrhythmias and channelopathies	Yellow (Y)	Red (R)
Atrial fibrillation, atrial flutter. Yes anticoagulation, no collision sports.	HR controlled effort and without structural pathology	HR uncontrolled effort or structural heart disease
Ventricular arrhythmia	VE > 2000/ 24 hours and does not increase with the effort	No VT or sustained increase in effort VE
Sinus bradycardia, 2nd degree AV block Mobitz I (Wenckebach)		HR < 30 bpm or pauses > 3 seconds or block that are not normalized with the effort
2nd degree AV block Mobitz type II or 3rd degree	Asymptomatic ^a , without heart disease and normalizes blocking the effort	Symptoms ^a , or underlying heart disease
Pre-excitation syndrome or paroxysmal supraventricular tachycardia	Recreation: radiofrequency ablation: suggested	Competitive: radiofrequency ablation: indicated
ICD	Only in sports without the risk of collision	
Brugada syndrome	Asymptomatic ^a	Symptoms ^a
Long QT syndrome or short	Asymptomatic ^a	Symptoms ^a
Catecholaminergic ventricular tachycardia	Asymptomatic ^a	Symptoms ^a

AV: atrioventricular; HR: heart rate; ICD: implantable cardioverter defibrillators; VE: ventricular extrasystoles; VT: ventricular tachycardia.

Yellow (Y): IA Mitchell competitive sport; recreational sport: low-moderate static component and intensity < 75%FC maximum or < 6 Borg Scale.

Red (R): competitive sport is contraindicated; recreational sport: under static component and intensity < 60%FC maximum or < 5 Borg Scale.

^a Symptoms: pre-syncope, syncope, resuscitated sudden death, malignant ventricular arrhythmia in Holter 24 hours or stress test.

Table 6 Recommendations in congenital heart disease^{9,19}

Congenital heart disease	Yellow (Y)	Red (R)
Septal defects (IAC or IVC)	Tricuspid insufficiency 2,8-3.4 m/s without RV dysfunction	Tricuspid insufficiency > 3.5 m/s > 2.8 m/s with RV dysfunction
Patent ductus arteriosus	Tricuspid insufficiency from 2.8 to 3.4 m/s without dilatation LV	Tricuspid insufficiency > 3.5 m/s or dilated LV
Pulmonary stenosis	Trans-pulmonary gradient > 40 mmHg or severe pulmonary insufficiency dilated RV (IA-IB)	
Cyanotic heart disease without surgery	Asymptomatic heart failure	Symptomatic heart failure
Tetralogy of Fallot	S1, risk criterion ^a or QRS width or severe pulmonary insufficiency	
Transposition of great vessels atrial switch (Mustard and Senning)	If, risk criteria ^a . Remember: do NOT do sports with high static component (III)	
Congenitally corrected transposition of the great vessels	If risk criterion ^a (IA-IB)	
Transposition of the great vessels operated (anatomical correction - arterial switch Jatene)	Mild impairment of the neo-aorta, mild pulmonary stenosis, mild ventricular dysfunction with normal stress test (IA-IB-IC-IIA)	Moderate-severe failure of the neo-aorta, moderate to severe pulmonary stenosis, moderate-severe ventricular dysfunction, myocardial ischemia in effort
Total cavo-pulmonary shunt - Fontan	Asymptomatic for heart failure without risk criterion ^a (IA-IB-IIA)	
Ebstein malformation	Severe tricuspid insufficiency without risk criteria ^a	Severe tricuspid regurgitation with risk criteria ^a
Anomaly of the origin of the coronary arteries		Contraindicated. Rate surgery

IAC: inter atrial communication; IVC: inter ventricular communication; LV: left ventricle; RV: right ventricle.

Yellow (Y): IA Mitchell competitive sport; recreational sport: low-moderate static component and intensity < 75%FC maximum or < 6 Borg Scale.

Red (R): competitive sport is contraindicated; recreational sport: under static component and intensity < 60%FC maximum or < 5 Borg Scale.

^a Risk criteria in congenital heart disease: a) ejection fraction < 40%(LV or RV); b) right ventricular pressure (> 50% of systemic pressure); c) ventricular arrhythmia; d) severe outflow tract obstruction; e) ischemia; f) O₂ saturation < 95%

Table 7 "Return to play" in competitive sport after interventional treatment

Treatment	Condition	Competitive sport
Post-ablation PSVT, WPW	No symptoms	After 1 week
Post-ablation or flutter AF	If you do not require anticoagulation for longer	After 1 month
Post-repair, surgical or percutaneous, IAC or IVC or PDA or coronary anomalies. Post implant ICDs	If no ventricular dysfunction or ischemia or arrhythmias with exercise	After 3 months

AF: atrial fibrillation; IAC: inter atrial communication; ICD: implantable cardioverter defibrillators; IVC: inter ventricular communication; PDA: persistent ductus arteriosus; PSVT: paroxysmal supraventricular tachycardia; WPW: pre-excitation syndrome.

ent cardiological therapeutic interventions that have been made. It is recommended, if the procedure has no complications, to start training progressively and scheduled in the days before competition.

Conflict of interests

Authors declare that they do not have any conflict of interests.

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