Clinical paper

Exercise related cardiac arrest in amateur athletes on the tennis court

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A R T I C L E  I N F O

Article history:
Received 22 November 2010
Received in revised form 28 February 2011
Accepted 20 March 2011
Available online xxx

Keywords:
Adult
Automated external defibrillator (AED)
Basic life support (BLS)
Bystander CPR
Cardiac arrest
Cardiopulmonary resuscitation (CPR)
Out-of-hospital CPR
Outcome
Witnessed cardiac arrest

A B S T R A C T

Aim of the study: The aim of this study was to study exercise-related cardiac arrests on the tennis court and investigate the impact of early initiation of cardiopulmonary resuscitation on survival rate and outcome.

Methods: This study was based on the cardiac arrest registry of the Department of Emergency Medicine at the General Hospital Vienna in Austria. Between February 1993 and April 2010 non-professional athletes were identified, who experienced exercise-related cardiac arrest on the tennis court. The analysis was accomplished using descriptive statistics. Results are presented as mean ± standard-deviation or median and interquartile range (IQR).

Results: The subjects (n=27) were predominantly male (96%) with a median age of 58 years; 52% of all patients had underlying cardiovascular risk factors. All cardiac arrests were witnessed. Bystander CPR was documented in 17 cases (63%). Median time from collapse to initiation of CPR was 1(IQR 0–2) minute. Ventricular fibrillation was the initial rhythm in 25 patients (89%) and in 3 an automated external defibrillator was used by bystanders. Twenty-four patients (89%) had return of spontaneous circulation before admission to the hospital and four (15%) followed verbal commands thereafter. The survival rate at 6 months was 82% with 20 patients (74%) having favourable neurologic outcome.

Conclusions: Cardiac arrest on the tennis court is a predominantly witnessed event with a respectively high rate of bystander CPR, which reflects in a high successful survival rate.

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1. Introduction

Sudden death from cardiac arrest is a frequently unexpected event that predominantly occurs outside the hospital, with traditionally poor survival rates. Exercise-related cardiac arrest is a rare but tragic event that leads to a high emotional response of the public. Individuals, who practice sport are usually regarded as healthiest members of the society.

Regarding the aetiology of non-traumatic sudden cardiac death following physical exercise an underlying cardiac disorder is predominantly seen.1 In younger athletes (<35 years) hereditary or congenital cardiac abnormalities are the main cause of death, especially hypertrophic cardiomyopathy or anomalies of the coronary arteries. On the contrary exercise related cardiac death in older individuals (>35 years) is attributable to an underlying atherosclerotic coronary artery disease.1–5 A paradoxical relation between physical exercise and cardiovascular disease exists. Physical inactivity is regarded as a risk factor for coronary heart disease,6 and exercise and physical activity is of particular significance in prevention of atherosclerotic cardiovascular disease.7,8 On the other side, vigorous exercise and exertion affects the hemodynamics of coronary arteries and platelet activation,13,14 triggering acute cardiovascular events.9–12 Several risk factors for exercise-related acute cardiac events in athletes exist, including a history of cardiovascular disease, smoking and fatigue or flu-like symptoms in the month preceding the event.1 However, prevention and prediction of exercise-related cardiac arrest turns out to be difficult. The American Heart Association and the European Society of Cardiology recommend medical pre-participation screening of young competitive athletes.15,16 It includes personal and family history of underlying cardiac disease or specific knowledge of certain cardiac disorders (e.g. hypertrophic or dilated cardiomyopathy or long QT-syndrome) as well as physical examination including arterial blood pressure measurement. The routine use of a 12-lead ECG is not recommended by the American Heart Association because of its low specificity and pretest probability to detect structural cardiovascular malformations in younger athletes or detect coronary artery disease in older trained athletes. The European Society of Cardiology takes a different position emphasizing the power of a 12-lead ECG to detect ECG changes due to hypertrophic cardiomyopathy. However the prevention of cardiovascular events in amateur ath-
After (96%), the median age was 58 (IQR 53–66) years. Exercise-related professional level. The subjects were predominantly male (All patients were amateur sportsmen who played tennis at a non-enced cardiac arrest on the tennis court were eligible for this study. Chicago, USA).

We wanted to identify the characteristics of exercise-related cardiac arrest on the tennis court and examine the overall survival rate and neurologic outcome of amateur sportsmen.

2. Methods

The data of this retrospective cohort study were based on the cardiac registry of the Department of Emergency Medicine, a tertiary-care facility. The registry was accredited by our institutional ethic committee. It contains data of all adult patients between 1991 and 2010 who experienced cardiac arrest of non-traumatic origin admitted and treated at the Emergency Department. The follow up of all patients included data collection of surveillance monitors and patient charts as well as neurologic evaluation following the Pittsburg Brain Stem Score18 and the Cerebral Performance Score20 criteria. The acquisition of data was performed at 6, 12, 24, 48, 72 h and 7 days, 30 days, and 6 months after restoration of spontaneous circulation. The documentation of data followed the Utstein Criteria-guidelines for cardiac arrest and cardiopulmonary outcome reports.19 The term exercise-related cardiac arrest was defined as cardiac arrest of non-traumatic origin during or shortly after (within 1 h) physical exercise. Return of spontaneous circulation was defined according to the Utstein Criteria as restoration of a spontaneous perfusing heart rhythm that results in more than an occasional gasp, fleeting palpated pulse, or arterial waveform.17

The primary endpoint for this retrospective study was the overall mortality six months after the event. The secondary endpoint was defined as best favourable neurologic recovery within 6 months. Favourable neurological recovery was defined as Pitts-

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The analysis was carried out with simple descriptive statistics.

Categorical variables are presented as counts and percentage, for continuous variables mean and standard deviation (SD), or median and interquartile range (IQR) were calculated as appropriate. All data were analysed using Microsoft Excel 2008 for MAC (Microsoft Corporation® Redmond, USA) and PASW Statistics 18.0 (SPSS Inc. Chicago, USA).

4. Results

Out of 3610 patients with cardiac arrest 27 patients who experi-
enced cardiac arrest on the tennis court were eligible for this study. All patients were amateur sportsmen who played tennis at a non-
professional level. The subjects were predominantly male (n = 26; 96%), the median age was 58 (IQR 53–66) years. Exercise-related cardiac arrests were observed during (n = 17; 63%) or within 1 h after (n = 10; 37%) physical activity. Regarding the past medical his-
tory 14 patients (52%) had a relevant previous medical history or risk factors for cardiovascular disease (Table 1). Nine patients had a history of smoking (33%), six had underlying coronary heart disease (22%) and five (18%) had a previous myocardial infarction.

In 23 cases (85%) the arrest was witnessed by bystanders, in 4 cases (15%) the event occurred in presence of the emergency medical service. Seventeen patients (74%) received initial basic life support via bystanders. Without antecedent symptoms 18 patients (67%) had collapsed; 9 patients reported preceding symptoms such as chest pain (n = 5; 19%), dizziness and discomfort (n = 2; 7%) or headache (n = 1; 4%) and palpitations (n = 1; 4%) (Table 2). Pursuing the patients follow up and the pathologic findings of the deceased individuals a cardiac aetiology for the cardiac arrest could be determined in 25 patients (93%). Twenty-one patients suffered an acute myocardial infarction, in three cases a fatal arrhythmia was causative and in one case the cardiac arrest was attributable to a Prinzmetal angina. The only female participant in this retrospective study suffered a cardiac arrest of non-cardiac origin; the patient developed a spontaneous subarachnoid hemorrhage. In one case the origin for cardiac arrest could not be determined because of lack of autopsy findings.

Ventricular fibrillation was observed as initial rhythm in the vast majority of all cases (n = 25; 93%), whereas asystole (n = 1; 4%) and pulseless electrical activity (n = 1; 4%) were only seen in 2 patients. The time from collapse to initiation of bystander CPR was a median of 1 min (IQR 0–2). In three cases (11%) the use of an automatic external defibrillator intensified initial efforts of bystander-CPR.

Table 1 Demographic characteristics, family history and relevant cardiac history of the cohort.

<table>
<thead>
<tr>
<th>Number of subjects</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, n (%)</td>
<td>26 (96)</td>
</tr>
<tr>
<td>Age (years), median IQR 25–75</td>
<td>58 (53–66)</td>
</tr>
<tr>
<td>No relevant medical history, n (%)</td>
<td>13 (48)</td>
</tr>
<tr>
<td>Relevant pre-existing conditions/cardiac risk factors, n (%)</td>
<td>14 (52)</td>
</tr>
<tr>
<td>Smoking, n (%)</td>
<td>9 (33)</td>
</tr>
<tr>
<td>Coronary heart disease, n (%)</td>
<td>6 (22)</td>
</tr>
<tr>
<td>Myocardial infarction, n (%)</td>
<td>5 (19)</td>
</tr>
<tr>
<td>Arterial hypertension, n (%)</td>
<td>2 (7)</td>
</tr>
<tr>
<td>Cerebrovascular insult, n (%)</td>
<td>2 (7)</td>
</tr>
</tbody>
</table>

Table 2 Resuscitation factors and outcome.

<table>
<thead>
<tr>
<th>Occurrence of cardiac arrest</th>
<th>During exercise, n (%)</th>
<th>17 (63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antecedent symptoms before cardiac arrest</td>
<td>None, n (%)</td>
<td>18 (67)</td>
</tr>
<tr>
<td></td>
<td>Chest pain, n (%)</td>
<td>5 (19)</td>
</tr>
<tr>
<td></td>
<td>Nausea/dizziness, n (%)</td>
<td>2 (7)</td>
</tr>
<tr>
<td></td>
<td>Palpitation, n (%)</td>
<td>1 (4)</td>
</tr>
<tr>
<td></td>
<td>Headache, n (%)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>First assessed cardiac rhythm</td>
<td>Ventricular fibrillation, n (%)</td>
<td>25 (93)</td>
</tr>
<tr>
<td>Asystole, n (%)</td>
<td>1 (4)</td>
<td></td>
</tr>
<tr>
<td>Puleless electrical activity, n (%)</td>
<td>1 (4)</td>
<td></td>
</tr>
</tbody>
</table>

Cause for cardiac arrest

| Cardiac, n (%) | 26 (96) |
| Cerebral, n (%) | 1 (4) |
| CPR initiation by bystander, n (%) | 17 (74) |
| CPR initiated by emergency medical service, n (%) | 10 (37) |
| Arrest witnessed by emergency medical service, n (%) | 4 (15) |

Time from collapse to initiation of CPR minutes, median IQR (1–2) - 4 (1–6) |

Adrenaline dose mg, median IQR (1–6) - 4 (1–6) |

Restoration of spontaneous circulation before arrival at hospital, n (%) | 24 (89) |

6-month survival, n (%) | 22 (82) |

Deceased on the intensive care unit, n (%) | 2 (7) |

Mild therapeutic hypothermia, n (%) | 9 (33) |

Best cerebral performance category (CPC) 1–2, n (%) | 20 (74) |
and 23 patients (85%) received manual defibrillation via the emergency medical service. The time from collapse to first defibrillation was a median of 6 min (IQR 4–10). In order to specify, the median time to defibrillation was 5 min (IQR 3–7) for the AED-group and 7 min (IQR 4–12) for manual defibrillation group.

Twenty-four patients (89%) had restoration of spontaneous circulation before admission to the hospital and three patients (11%) were admitted with ongoing cardiopulmonary resuscitation and did not sustain restoration of spontaneous circulation at all. Out of the 24 cases the time from collapse to restoration of spontaneous circulation was a median of 12 min (IQR 8–20). Four patients (15%) followed verbal commands immediately after restoration of spontaneous circulation presenting with a Glasgow Coma Scale (GCS) of 14–15 at the emergency department; three of them belonging to the AED-group.

The survival rate at 6 months after cardiac arrest was 82% (n = 22). Three patients (11%) did not sustain restoration of spontaneous circulation, two patients (7%) died at the intensive care unit, as a consequence of cardiogenic shock in one case and due to multi-organ failure in the other case. Regarding the neurologic function 20 patients (74%) scored a best cerebral performance category of 1. Fortunately all 3 patients defibrillated via an AED survived and scored to a cerebral performance category of 1. The time from restoration of spontaneous circulation to hospital discharge in cardiac arrest-survivors was a median of 19 days (IQR 11–33).

5. Discussion

The vast majority of exercise-related cardiac arrest occurred in men with a presumable underlying cardiac disease. Although at least nearly fifty percent of the individuals had risk factors for cardiovascular disease, nearly half of the patients were considered as “healthy” individuals without a relevant past medical history. In these cardiac arrest was the first manifestation of an apparent cardiac disorder. Unfortunately routine physical examination before exercise was not performed, because asymptomatic amateur athletes usually do not consult a physician before pursuing sports.

The predominance of male individuals undergoing exercise-related cardiac arrest may result from the fact that a cardiovascular disease is seen more often in male patients.21 The incidence of exercise-related acute cardiovascular events is approximately five times higher in men than that observed in female athletes.22–24 In our study all cases of exercise-related cardiac arrest occurred in male participants could not reflect the occurrence of cardiovascular disease, nearly half of the patients were considered as “healthy” individuals without a relevant past medical history. In these cardiac arrest was the first manifestation of an apparent cardiac disorder. Unfortunately routine physical examination before exercise was not performed, because asymptomatic amateur athletes usually do not consult a physician before pursuing sports.

The sample size of this retrospective study may not be representative for all exercise-related cardiac arrests during the time period studied, because only patients admitted to our department were included. According to the Vienna Ambulance Service between 2007 and 2010 all patients who suffered an exercise-related cardiac arrest on the tennis court were admitted to a hospital. With exception of one case all patients were admitted and treated at our department. After revision of our data the number of out-of-hospital cardiac arrests in the tennis court was calculated to a median of one case (IQR 1–3) per year, in the urban region of Vienna, with 1,550,000 inhabitants. Unfortunately we have no access to the data of the Vienna Ambulance Service during the whole study period. Therefore the compound of subjects in our study and the majority of male participants could not reflect the occurrence of sports-related acute cardiovascular events of a general population.

6. Conclusion

Exercise-related cardiac arrests on the tennis court are predominantly witnessed events. The limitation of pre-participation screening of asymptomatic athletes with underlying cardiovascular disease can only be overcome by increasing sufficient basic life support providers and improvements in pre-hospital care. Early defibrillation and the use of automated external defibrillators play an important role in improving survival from out-of-hospital cardiac arrest.34,35 As already mentioned, nearly all patients in our study presented ventricular fibrillation in the first assessed ECG. However, only three patients received early defibrillation via an automated external defibrillator. This can be explained by the fact that one part of our patients underwent cardiac arrest before the commercial introduction of automatic external defibrillators in Austria, another reason is the fact that many sports facilities still are not equipped with an automatic external defibrillator.

Out of all patients in our study, who suffered exercise-related cardiac arrests, in 74 percent a good neurologic recovery could be observed. The introduction of mild therapeutic hypothermia in the post-resuscitation care of comatose survivors has shown to improve survival and neurologic outcome after cardiac arrest.36,37 In our trial only 9 patients (33%) received cooling. This was the result from the fact that 4 patients were able to follow verbal commands after restoration of spontaneous circulation, 3 patients did not sustain restoration of spontaneous circulation, 4 patients participated in the control-group of the hypothermia after cardiac arrest-trial37 and 5 patients were admitted to our department before introduction of mild therapeutic hypothermia. The only female patient underwent a neurosurgical intervention due to a subarachnoid hemorrhage, and in one case hypothermia was not used after transfer to an intensive care unit.

Conflict of interest statement

The authors have to disclose no financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work.

References


