CARDIAC SCREENING AND CARDIAC ARREST ON THE PITCH

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The whole football world shockingly watched the event of Christian Eriksens collapse during the Denmark-Finland game at the Euros, in June 2021. After successful resuscitation he survived the event of sudden cardiac arrest (SCA). While everybody was relieved at this turn of events, the question was asked: can this be prevented?

In the last 20 years a great development in cardiac health of athletes has taken place. Way back, the importance of pre-screening of athletes included the 3H´s (heart, hernia and how do you feel?). However, in many countries in the beginning of the 1980´s, you could play at highest level without ever being evaluated for heart conditions. This may be due to several reasons, but the lack of specificity of ECG-interpretation of athletes was one obstacle. Then in the 2000´s Sports Cardiology was established as part of the European Society of Cardiology (ESC) and American Heart Association, worldwide leading cardiology societies.

The first recommendations from the ESC for cardiac screening for competitive athletes was published in 2005[1]. Since then, international recommendations for the interpretation of the ECG in athletes has been produced in 2017[2]. In 2021, for the first time Guidelines of Sports Cardiology from the ESC, on sports and exercise in athletes with underlying cardiovascular disease, was published[3]. Importantly, as a result of varying degree of readiness for adverse cardiac events at arenas, recommendations for arena safety, including a medical action plan (MAP), was produced in 2011 by the ESC[4], and subsequently by FIFA[5]. This development has been possible as a result of the increasing knowledge in the field of Sports Cardiology. Now, Sports Cardiology is a recognized sub-speciality of Cardiology in Europe[6], hopefully expanding towards a common worldwide curriculum.

The causes of sudden cardiac death in young athletes (<35 years) are mainly, but not exclusively, inherited cardiac abnormalities such as hypertrophic cardiomyopathy (HCM), arrhythmogenic cardiomyopathy (formerly right ventricular cardiomyopathy), coronary artery anomalies, long QT-syndrome and various ion-channel diseases (Brugada syndrome, PCVT...)[7]. A number of cases cannot be attributed to any specific underlying disease. However, most of these cases are expected to show underlying disease, as genetic testing is developing[8]. Overall, 1/250 athletes are expected to show an underlying cardiac abnormality, being associated with increased risk of SCA during sports. Many of these entities show abnormalities on the resting 12-lead ECG, and individuals suffering from SCA often have previous symptoms, such as exercise-related yncope, dyspnoea, palpitations or chest pain and/or show a familiar history of SCA and/or inherited cardiac disease[9].

SCREENING- FIRST LINE OF DEFENCE

Because of the possible preventability of these events, recommendations on cardiac screening were produced, both in Europe and in the US[1,10]. They include:

1. Careful evaluation of family history and cardiac symptoms.
2. Physical evaluation.
3. 12-lead resting ECG[1].

The sensitivity of the screening recommendations has been shown to be high, and thus, the potential for detecting

Image: Christian Eriksen receives medical treatment during the UEFA Euro 2020 Championship.

a majority of individuals with underlying disease. For example, a recent Swedish study, including all cases of sudden cardiac death (SCD) due to HCM in young athletes, showed that 88% of cases, showed any abnormality (family history, symptoms or ECG-changes) prior to death[11]. Indeed, relying on family history, symptoms and physical evaluation has shown considerably lower sensitivity, with the ECG adding significantly to the sensitivity of screening[12].

The main issue of cardiac screening including ECG, concerns the specificity. Indeed, cardiac screening without the ECG has very low specificity, due to the often diffuse, potentially cardiac, symptoms listed above[13]. These symptoms are very common in athletes and therefore needs to be penetrated by an experienced (team) physician. Often, this evaluation will necessitate a resting-ECG.

However, also the ECG has limitations. Physiologic adaptations, secondary to long-standing, sporting activities, may also affect the heart. The degree of adaptation, will depend on several factors, including the type of training, intensity, level of sporting activity, age and duration of the training exposure, ethnicity, and sex[14]. These changes, typically referred to as "athlete´s heart" will involve enlargement of the cardiac ventricles and walls, of varying degrees. If significant, these changes will be recognized by a resting-ECG. However, various underlying cardiac abnormalities also show ECG-changes, which may be similar to the ones resulting from physiologic adaptation[2]. Historically, manual percussion of cardiac size and later, x-ray, were the first diagnostic tools, indicating an "enlarged heart". The ECG has refined this categorization and repeated updates of recommendations on how to interpret the ECG in athletes, differentiating physiologic adaptations from underlying pathology, has refined the criteria for abnormality. Today, ECG shows high sensitivity (as before), but also a markedly improved specificity, with a few % "false-positives" at best. This development has greatly aided the implementation of screening recommendations in clinical practice, including FIFAs pre-competition medical assessment (PCMA)[15]. In case of uncertainty, symptoms and/or ECG-abnormalities suspected to be non-physiological, additional evaluation by echocardiography and/or exercise-testing is advocated[2,16]. The advantages of the ECG are the widespread availability, low cost and high sensitivity. However, there is still a need to increase the knowledge of cardiac screening in general and specifically of ECG-interpretation, in sports medicine physicians and team doctors, outside the field of cardiology.

Cardiac screening is not 100%. Although screening has the potential to discover the majority of individuals with an underlying significant cardiac abnormality,

a part of athletes will go unnoticed, having subclinical disease. For the young, this would most probably be ion-channel disease. As proposed, widening the screening to make echocardiography mandatory, would have cost implications. However, major sporting organizations, such as FIFA and UEFA, have decided to make echocardiography mandatory, as part of the pre-competition medical assessment (PCMA)[15] at this level of competition, where it is both logistically and economically feasible.

CARDIAC ABNORMALITIES NOT DETECTED BY SCREENING

Not all cardiac entities are detectable by screening. In the case of infectious myocarditis, mainly caused by cardiotropic viruses, prevention is the key. No player should be recommended to play or train, during an ongoing infection. This has been particularly highlighted during the covid-pandemic. While the initial worry about an abundance of cardiac complications to covid[17], has been partly downplayed, also covid could cause myocarditis, and possible non-infectious cases of myocarditis post-vaccination, has been described[18].

Another special cardiac event, not possible to prevent by cardiac screening, is commotio cordis. This entity is a major cause of SCA in the (very) young athletes, in the US often associated to baseball, but has also been described in ice-hockey and football[19]. The unlucky hit of a non-air-filled object (puck, baseball) in the chest area, over the heart, at a certain time frame in the heart cycle, could give rise to malignant arrythmias, including ventricular tachycardia and even death. Commotio cordis is hard to prevent, although protective gear and softer balls have been tried. The major line of defence is appropriate cardiac resuscitation in case of SCA.

ARENA SAFETY- SECOND LINE OF DEFENCE

Alas, readiness at sporting events, in case of SCA is essential. "Arena safety", thus constitutes the second line of defence, to save an individual from death, in case of SCA.

The major factor associated with survival from SCA, is time to cardiopulmonary resuscitation (CPR) and time to defibrillation[20]. Thus, one major factor is the early recognition of an arrest. While SCA is an uncommon event, team doctors should be aware of the signs of an arrest, so minimal "doctor´s delay" occurs. Always, when a player collapses without any visible trauma, and falls to the ground, SCA should be suspected. The immediate actions, include determining ABC (airway, breathing, circulation) as soon as the player is reached. If no signs of consciousness, pulse and breathing, SCA is established and CPR must be initiated, ideally within 1 minute from the event occurring[4,20]. While CPR commences, pitch medical staff, will be summoned, for application of an automated external defibrillator (AED), in case of arrest, ideally within 3-5 minutes[4].

The 30-day survival of exercise-related out of hospital cardiac arrests, are significantly higher compared to non-exercise related out of hospital arrests[21]. This is due to a combination of a higher degree of arrests being witnessed; by earlier CPR and earlier defibrillation. While women show a much lower incidence of SCA during sports, the survival from arrest is lower[21,22]. This merits consideration, and future studies, as the suspicion of women having a cardiac arrest may be lower. This is indicated by the findings of a lower rate of and slower initiation of CPR, in women[22]. Sex-related differences in underlying cardiac abnormalities may also be of importance, as could differences in sporting activities between genders worldwide. The survival of the youngest in case of SCA has been debated. In the Swedish study, however, the survival was not lower for the youngest athletes (<25 years) compared to the older and the 25-35 year olds[22].

The significance of an AED was established outside sports, in surroundings such as casinos and airports, showing a higher survival when AEDs were present. This development has led to the vast increase in AEDs in public places (also taxis and shopping malls etc) as well as in sports stadiums. However, it is important that just placing an AED in a stadium or training

Image: Christian Eriksen visits Appiano Gentile to meet teammates.

ground is not enough. The establishment of a medical action plan (MAP) is essential[4]. The MAP should include information on the responsible doctor, the personnel, communication methods and equipment of the stadium, but also on how training of the medical staff is ascertained. The MAP should also include information on how to connect to the regular emergency care in a particular city, from the stadium and onwards. Any weak link in this "chain" may result in a lower survival, in case of SCA.

IS IT WORKING?

The effectiveness of a cardiac screening programme is difficult to evaluate. The occurrence of SCA is low and any intervention studies, needs to be carefully constructed. Do we have any evidence? No randomized controlled study of screening vs no screening has been performed, and the likeliness of such as study taking place is low. However, we have some studies indicating the effect of screening and arena safety. The most known study, is the one on cardiac screening in the Veneto-region of Italy, showing a marked decline in the incidence of SCD associated to cardiac screening being introduced[23]. The incidence of SCD in the athletic population, was actually lower than the incidence of SCA in the normal population! However, the rates of SCD at the beginning of the study was comparatively high, contributing to the results. For any study to be useful, we must have a non-selected population, ideally comprising all individuals of a large region or even a country. The Swedish national registry of SCD in ALL young individuals <35 years of age, offers opportunities to study both aetiology and incidence of SCA in a totally unselected and comprehensive population (the whole population). Interestingly, we could show that the number of athletes suffering from SCD in the years 2000-10 was half that, compared to the years 1990-99[24]. The study cannot determine which factor was the most important: the introduction of screening, education and/or the increased availability of AEDs in public places and sports arenas. All these things have developed during the years since the mid-1990´s and could be contributing to the results at a varying degree. However, the study perfectly illustrates the potential to decrease a nation-wide incidence rate of SCA, by applying the "lines of defence", discussed in this paper.

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EDUCATION-THIRD LINE OF DEFENCE?

The need for (further) education at different levels of medical staff and on different topics could be identified, including on:

- How to perform cardiac screening, for the team physician. This also includes interpretation of ECG´s, recognizing the major abnormalities or "red flags", indicating the need for further evaluation by a cardiologist.
- The transfer of theoretical knowledge of handling of an SCA to practical training. Clinical training sessions, or courses are needed for the relevant medical personnel, especially those present at sporting events with a significant number of participants and/or spectators.
- How to produce a medical action plan (MAP) for physicians engaged in event planning.
- Increased basic knowledge in the field of Sports Cardiology, including aetiology of SCA at various ages etc, should be part of any future sports medicine/football medicine education/curriculum.

SUMMARY

The field of Sports Cardiology has experienced a very exciting development in the last decades, now being recognized as a vital part of any football doctors´ broad knowledge. The combination of cardiac screening and arena safety measures, alongside public and professional knowledge and awareness, has the potential to reduce the incidence of SCA and most importantly SCD in sports. While much research remains to be conducted, the implementation of the present knowledge in screening and arena safety will help the athletes and medical staff in this endeavour.

References

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