



**EXTREME EXERTIONS AND CONGENITAL HEART ABNORMALITIES
LEADING TO COMMOTIO CORDIS AMONG ACTIVE SPORTS-
PERSONS: A REVIEW ON EMERGENCY
OUTBREAK ON-FIELD**

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ABSTRACT

Sports are meant for fun and health benefits with minimal injury and damage risks. Unfortunately, it is during some occasions that athletes, coaches, and even spectators go through serious life-threatening medical emergency situations. It is very important for everyone to know when an event is considered an emergency and what could be the reasons behind it. Injuries are always a part of an athlete's life, but one should not risk their life to fulfill the demand of the game. Accidents may happen during sports and it is very important to limit the degree and number of injuries with preventive measures. First priority is to avoid any mistake which can result in an injury or a sudden and painful fall of an athlete on-field. Instances of sudden cardiac death are becoming the leading cause of death among young athletes. No obvious symptoms are being known before an actual incident takes place on-field. The most common causes behind sudden cardiac arrest leading to a life-threatening moment are abnormal heart rhythm, cardiomyopathy, and acute myocarditis or inflammation of the heart muscle. Also, extreme exercise load and vigorous training can increase the risk of a serious emergency. If any additional stress is put on the heart from dehydration, heat, or a recent illness, that could have an impact and lead toward seriousness. The study is to review the causes behind the outbreak of emergency situation on-field due to extreme exertions and congenital heart abnormalities leading to Commotio Cordis among active sportspersons.

Keywords: Cordis; Death, Heart Rhythm, sportspersons, Abnormality.

1. INTRODUCTION

It is a big challenge to avoid and overcome the sudden death of athletes during training and on-field due to cardiac arrest. Most causes are related to cardiovascular problems without any symptoms noted before the fatal event. The common symptom is fainting or near-fainting during activity or training. The victims may belong to various professional sports. Commotio Cordis is a fatal mechano-electric syndrome that is the second most common cause behind sudden cardiac death of athletes. Mostly, connected with those sports where there are more chances of high-velocity contact between an object and an athlete, especially in the chest area. As a result of this impact, malignant arrhythmias consequently develop leading to the individual's immediate death (Menezes et al. 2017).

The heart is a muscular pumping organ made up of cardiac muscle that generates the force required for blood circulation throughout our body. Blood circulation is very important for survival; our cells need a continuous supply of oxygen and nutrients, consequently maintaining all metabolic activities in our body. Blood is the connective tissue, is the transportation medium, the heart keeps the blood moving through the vessels and various parts of the body. A normal heart (in the case of an adult) pumps around 5 liters of blood per minute throughout. Losing the pumping effectiveness for a few minutes results in the individual's life under threat.

The Human Heart Beat: An electrical stimulus is generated by the sinus node (sinoatrial node or SA node) which is located in the right upper chamber(atria) of the heart. An electrical stimulus is generated by the sinus node regularly at a rate of approximately 60 to 100 beats per minute under normal conditions. The electrical stimulus travels down through the conduction pathways and enables the heart's ventricles to contract and pump blood. Firstly, two upper chambers are stimulated, and secondly the two lower chambers. Then the electrical impulse travels from the sinus node to the atrioventricular node or AV node, here impulses are slowed down for a very short period. Each contraction of the ventricles is termed as one heartbeat. The special pacemaker cells generate electricity in the upper chamber or atrium of the heart. This electrical spark is carried through the pathways in the heart so that all the muscle cells contract at once and produce a beat that is heard and felt as a heartbeat. This mechanism helps to pump blood through the heart valves into all the organs of the human body. The body collapses when the heart muscle cannot supply blood to the brain and other parts of the body.

The most common reason for sudden death among patients is Ventricular fibrillation, which is treated with an electrical shock within less than 4-6 minutes to minimize the brain damage and effectiveness. Automatic External defibrillators (AEDs) can be used by anybody to treat themselves by themselves. The sudden death of a person is most often caused by heart disease or heart problems. There may be many types of injuries, illnesses, or environmental conditions that might cause an athlete to collapse on-field or during training.

Exercise Associated Collapse (EAC): Athletes unable to stand or walk without support as a result of lightheadedness, faintness, and dizziness or syncope causing a collapse that occurs after the completion of an exertional event or stopping exercise.

Sudden Cardiac Death (SCD): Sudden Cardiac Death (SCD) is a cardiovascular cause that occurs when the heart stops beating or not beating sufficiently to maintain perfusion and life.

2. REVIEW OF RELATED LITERATURE

The diagnostic tests to screen for cardiovascular abnormalities are ineffective and inefficient. The most prudent and effective methods of pre-participation screening for cardiovascular abnormalities at this time are history and physical examination in accordance with the American Heart Association guidelines. Also, suggested for sports trainers and coaches

check and ensure that every sports training institute should maintain these minimum standards for athletes (Koester, 2001).

The exercise acts as a trigger for sudden cardiac death in people with cardiovascular disease. Sudden death among young athletes who are diagnosed with a medical history of cardiovascular disease is predicted to be 2.5 times higher than that among non-sportspersons. 90% of the cases due to sudden cardiac attacks resulting in death mainly occur during or immediately after training. Concluded that the incidence of sudden cardiac death in any population including athletes varies depending on multiple parameters including sex, age, ethnic group, nationality, screening methods to reveal sudden death, and attempts to prevent or avert sudden death. It also depends upon the definition used and how the diagnosis is made (Farzin, Tohid, and Reza, 2011)..

Sports-related SCD could be prevented and minimized by understanding the causes and mechanisms of such events. Suggested for the young athletes to undergo pre-participation screening along with family medical history i.e. parents, a physical fitness test, and an ECG report. This will help to identify those athletes who are at high risk for SCD and also a detailed evaluation by a cardiologist should be mandatory for all (Amit et.al., 2017).

Karin B. et al. (2006): Found in their study that SCD occurs more frequently among young athletes less than 18 years of age, and the suspected cause behind is a pre-existing congenital cardiac abnormality. Premature atherosclerotic disease is another cause among young adults.

Sudden death is very rare among fit young individuals. But, their deaths cause widespread public attention as they are considered the epitome of physical health and fitness. A histopathologist can go for a detailed examination of the heart to find the cause of death whether it was due to a CAD, cardiomyopathy, valve abnormality, major vessel rupture, or ion channelopathy mechanism. Looking at the present scenario of various incidents taking place in the field of sports, the cases must be properly examined by an expert cardiac pathologist (Sheppard, 2012).

According to the Sudden Cardiac Arrest Association, a heart attack stems from circulation, or "plumbing," problem of the heart; which happens during a sudden blockage takes place in the coronary artery severely reducing or cutting off the blood flow towards the heart resulting damaged heart muscle. A sudden cardiac arrest takes place due to an electrical problem in the heart. As a result, the heart may beat very fast, causing the heart's ventricles to quiver or flutter instead of pumping blood in a coordinated fashion (Katherine, 2014).

3. OBSERVATION

It is a very well-known fact that exercise is good for all. But, chronic extreme exercise training and competing in endurance events can lead to heart damage and rhythm disorders. Due to the emerging growing standards of competitive sports, athletes are forced to push harder beyond the limits and undergoing extreme training sessions is a cause behind the sudden breakdown of athletes.

A study was conducted on marathon runners and it was being found that even after finishing extreme running events, athletes' blood samples contain biomarkers that are associated with heart damage. These damage indicators normally get away by themselves, but when the heart is pushed towards extreme physical stress, again and again, the temporary damage may lead to thicker heart walls and scarring of the heart. Moreover, further research found evidence that high-intensity exercise can acutely increase the risk for sudden cardiac arrest or sudden cardiac death in individuals with underlying cardiac disease. This in turn increases the risk of

heart rhythm disorders, especially for young ones who have hypertrophic cardiomyopathy or coronary heart disease.

Researchers also found that people who have exercised well over the National Physical Activity (USA) guidelines for many years were more likely to develop Coronary Artery Calcification (CAC) by middle age. CAC can be measured with CT scans which indicate that calcium-containing plaques are present in the arteries of the heart indicating heart disease.

The U.S. Department of Health and Human Services “2008 Physical Activity Guidelines for Americans Trusted Source” recommend for adults to do at least 150 minutes of moderate-intensity aerobic activity (walking, hiking, golfing, home exercises, and gardening) a week, or 75 minutes of vigorous-intensity aerobic activity (running, biking, swimming, exercise or dance classes, and strenuous sports) a week. People who have exercised three times higher than the recommended amount or the equivalent of 450 minutes of moderate aerobic activity a week had a 27% higher risk of developing CAC compared to those who exercised less.

Christian Eriksen, 29-year-old Denmark’s footballer (midfielder) collapsed during the Euro 2020 football match against Finland in Copenhagen on June 12, 2021, due to a heart attack as per doctors. Good health and physical fitness are not enough to ward off cardiac problems. Christian Eriksen was lucky enough to survive because First-Aid was on hand and the support from the medical team. Sudden cardiac arrest is a leading cause of death among sportspersons and there are no warning signs, and athletes collapse in the middle of training or during matches in most cases.

Sudden cardiac arrest generally comes without a prior warning, immediate medical attention is very necessary, or else severe causality may occur. A person can feel sudden fibrillation instead of a steady contraction and expansion (the rub-dub rhythm)owing due to a disruption in the electrical rhythm causing a cardiac arrest. Structural or electrical abnormalities can cause sudden cardiac arrest in sportspersons. Exercise can be a trigger for some athletes with an abnormal heart condition. In some sports where there is a possibility of direct contact, a hard blow to the chest can result in sudden cardiac arrest, and it is called “Commotio Cordis.” Nowadays, due to more physical exertion cardiac arrests strike people who are very fit and follow a healthy active lifestyle. The heart has its capacity for a certain level of exertion and the chances of thickening of the heart muscle are higher if an athlete constantly overworks it (**Dr. (<https://gulfnews.com/uae/health/why-super-athletes-like-christian-eriksen-suffer-heart-attacks-1.1623932875687>).**)

All athletes must be medically evaluated constantly without differentiating them on basis of their levels or categories. And since medical evaluations may not help uncover certain underlying health issues, experts insist on Electrocardiogram (ECG) screenings for detecting heart abnormalities that could minimize the risk of sudden cardiac arrest through a pre-signal. Automated Electric Defibrillator (AED) devices should be installed in public places such as malls, gyms, schools, community hot-spots, and others. But it is also very essential to have adequate knowledge of CPR and defibrillation to save a life (**<https://gulfnews.com/uae/health/why-super-athletes-like-christian-eriksen-suffer-heart-attacks-1.1623932875687>**).

The warning signs of a sudden cardiac arrest include; Fainting spell during exercise; Chest pain while exercising; Excessive shortness of breath during exercise; unexplained palpitations; and unexplained seizures. According to a report, one or two in every 100,000 active sportspersons experience sudden cardiac arrest each year where males dominate at the greater risk zone than the females. Also, it was found that the risk of cardiac arrest prevails among

African American athletes than the Caucasian athletes (Sports Institute at UW Medicine, University of Washington, Seattle).

5. DISCUSSION

Pheidippides' story inspired the famous modern sporting event which we call the marathon race. Pheidippides ran from Marathon to Athens to deliver the news of the victory of the battle of Marathon. He ran continuously from Marathon to the Court of Athens and collapsed as immediately after conveying the message to the court. Marathon event is organized and continuing till date in remembrance of the great running legend Pheidippides. Pheidippides' cause of death is extreme continuous stress on the heart resulting in heart failure.

The year 2006 marked a historical record in the field of sports in India when Budha Singh (4 years) boy from Odessa ran a total distance of 65 km continuously covering between Puri and Bhubaneswar in just seven hours. He became an instant sensational sporting phenomenon in India as a small boy capable to run a Marathon event with just a 4-year young heart. Budhia's 65 km run is recorded in the Simca Book of Records'. Further, he also ran 48 Marathons. The running era of Budhia came to an end after a controversy erupted over allegations that his coach was exploiting the child as medical health science suggests that the four-year boy's heart is too young to run a marathon, which is true (Debabrata, 2021).

Sports and Sudden Cardiac Death: There are a number of cardiovascular abnormalities which represent the most common causes of sudden death in competitive sports. The specific pathologies which are responsible for athletic field catastrophes vary with regard to the type of sport, age, and gender. These deaths occur mostly in team sports such as basketball and football, which have the highest levels of participation. The main cause of death is coronary artery disease among athletes who exceed 35 years of age. The general population may be having:

- i. Hypertrophic Cardiomyopathy.
- ii. Congenital Coronary Artery Anomaly.
- iii. Arrhythmogenic Right Ventricular Dysplasia (ARVD).
- iv. Marfan syndrome.
- v. Myocarditis.
- vi. Wolff–Parkinson–White syndrome (WPW).
- vii. Congenital long QT syndrome.
- viii. Brugada syndrome.
- ix. Commotio Cordis.

Some of the sports which have a risk for this cause of trauma are; Baseball, American Football, Association Football, Ice Hockey, Polo, Cricket, Softball, Pelota, Fencing, Lacrosse, Boxing, Professional Wrestling, and Martial Arts. Mainly, children are vulnerable because of the mechanical properties of their thoracic skeleton.

The Physical Burnout: The American Heart Association (AHA) recommends an adult to engage in either ≥ 150 minutes/week of moderate-intensity aerobic exercise, 75 minutes/week of vigorous aerobic exercise, or a combination of both for optimal overall health and well-being. Maintaining a physically active lifestyle has offered a number of health benefits; including increased productivity, improved sleep, reduced stress, greater heart health, and enhanced immune system support. On the contrary, too much exercise can have serious detrimental effects on our health. Exercising exceeding 300 minutes/week could trigger a "physical burnout," and maybe jeopardize our health.

The Overtraining Syndrome (OTS): One of the cardinal signs of overtraining is decreased athletic performance, regardless of increased training intensity or volume. This performance decrease can be related to (Naveed Saleh, 2020):

- i. Impaired agility.
- ii. Slower reaction times.
- iii. Reduced running speeds.
- iv. Decreased strength or endurance.

The cellular mechanisms of Commotio cordis are still not understood properly, but could probably be related to the activation of mechano-sensitive proteins and ion channels. These trigger extra electrical excitation waves which can increase ventricular fibrillation. The human heart has an upper limit to absorb the impact of energy applied on it; the excess amount of energy will create structural damage to the walls of the heart as well as an electrical malfunctioning.

TABLE 1
SHOWING THE SUDDEN CARDIAC DEATHS OF 387 AMERICAN YOUNG
ATHLETES BELOW 35 YEARS OF AGE WERE ANALYZED DURING
A MEDICAL REVIEW IN 2003.

Causes of Sudden Death in Young Athletes	
Cause of Sudden Death	Percentage of Death
Hypertrophic cardiomyopathy	26%
Commotio cordis	20%
Coronary artery anomalies	14%
Left ventricular hypertrophy of undetermined origin	7%
Myocarditis	5%
Ruptured aortic aneurysm (Marfan syndrome)	3%
Arrhythmogenic right ventricular cardiomyopathy	3%
Tunneled coronary artery	3%
Aortic valve stenosis	3%
Atherosclerotic coronary artery disease	3%
Other diagnosis	13%

Source:https://en.wikipedia.org/wiki/Sudden_cardiac_death_of_athletes

Most cases of sudden cardiac death are related to acquired cardiovascular disease. Commotio Cordis is an exceptional case during which the heart is structurally normal but loses the rhythm. The fatality rate is near about 65% with prompt cardiopulmonary resuscitation and defibrillation and found more than 80% without cardiopulmonary resuscitation and defibrillation. Mid 30 of an individual is very crucial as it serves as an approximate borderline for the likely cause of sudden cardiac death. Before the age of 35 years, congenital abnormalities of the heart and blood vessels predominate and after the age of 35 years, acquired coronary artery disease predominates (80%) regardless of the athlete's former level of fitness. Consumption of various 'Performance-Enhancing Drugs' (PED's) by athletes can also increase the chances for cardiac risk.

6. CONCLUSION

Sudden cardiac arrest is one of the leading causes of death among young athletes which is typically a result of a congenital heart abnormality or a blow to the chest which the heart may be unable to cope with extreme exertion on it; resulting a Commotio cordis. Athlete should be

monitored on regular basis without any failure to detect any abnormality such as arrhythmic heartbeat.

Sudden cardiac death (SCD) associated with athletic activity is generally rare but also a devastating event. Victims may be young ones and apparently healthy but many of the cases are unexplained and undiagnosed. As a result, there is a great importance and need for early identification of such at-risk individuals or athletes for whom an appropriate activity restriction can be imposed to minimize the risk. In most cases of SCD among athletes are due to Malignant Arrhythmias, Ventricular Tachycardia (VT) or Ventricular Fibrillation (VF). Among those individuals with certain cardiac disorders (e.g. Hypertrophic Cardiomyopathy, Arrhythmogenic Right Ventricular Cardiomyopathy etc.), vigorous athletic activity and training may increase the chances of VT/VF:

- i. A prolonged vigorous physical training may induce changes in cardiac structure (for example: interstitial fibrosis, disruption of normal myocardial architecture, dilation of right and left ventricle) among individuals those who are suspected with a pathologic arrhythmogenic substrate.
- ii. Intensive physical training can trigger various physiological demands such as hemodynamic overload, catecholamine release, and electrolyte imbalance. Also it can trigger malignant arrhythmias among those individuals who are suspected with some cardiac abnormalities.

The heart adapts to the stress of exercise and superior physical fitness does not guarantee for protection against exercise deaths. Vigorous and strenuous exercise and activity temporarily raises the risk of sudden cardiac arrest. But on the other hand, exercising on a regular basis has some good effect on other cardiac risk factors like reducing and controlling high blood pressure, obesity, and high cholesterol level. Further experimental research studies are recommended to figure out the failure of heart among young active sportspersons around the globe. Sport always meant for the betterment of humanity and upcoming bright and peaceful future on earth, not in sacrificing human lives.

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