



# EFFECTS OF ANABOLIC STEROIDS IN ATHLETES: INCREASED RISK FACTORS FOR MYOCARDIAL INFARCTION

**Dr. Vandana Singh**

Patna Women's College, Patna (Bihar) India

**Abstract:** Anabolic androgenic steroids (AAS) have a number of adverse effects on the cardiovascular system that can lead to sudden cardiac death. Long-term abuse of anabolic steroids by athletes has been reported by many researchers to result in a low cardiac ejection fraction. Anabolic androgenic steroid abuse has been associated with acute myocardial infarction and fatal ventricular arrhythmias. Anabolic steroids are not only present in professional sports but also affect amateur athletes who are making increased use of performance-enhancing drugs. The primary objective of the article is to improve awareness of the risk factors and consequences of adverse effects of anabolic steroids by athletes and to save the lives of athletes due to heart attack (myocardial infarction). Anabolic androgenic steroids are the most commonly used substances. To improve an athlete's exercise performance and body image. Heart attack is scientifically also known as acute myocardial infarction, which occurs when the blood supply to the heart is cut off or a clot forms. Heart disease is still the leading cause of death in India. Common risk factors and causes of heart attack are diabetes, high blood pressure, obesity, family history of heart disease, sedentary lifestyle, smoking, occupational and academic stress, drinking too much alcohol, poor dietary habits, HIV, high cholesterol level and old age etc. Excessive use of anabolic steroids has been associated with the development of a reversible dilated cardiomyopathy and potentially severe heart failure and cardiac arrest.

**Key Words:** Myocardial infarction, cholesterol, sudden cardiac, Lipids, Left ventricular hypertrophy, Athletes

## I. INTRODUCTION

A myocardial infarction (MI), commonly known as a heart attack, is caused by a reduction or complete cessation of blood flow to a portion of the myocardium. Myocardial infarction may be "silent," and go undetected, or it could be a catastrophic event leading to hemodynamic deterioration and sudden death [1]. Common symptoms of a heart attack are severe pain in the center of the chest, pain in the left upper back, pain in the left arm, shoulder and jaw, shortness of breath, sweating or sweating even in cold environments, unusual difficulty in climbing stairs or difficulty walking, feeling unwell, fainting, and vomiting. Common risk factors and causes of heart attack are diabetes, high blood pressure, obesity, family history of heart disease, sedentary lifestyle, smoking, occupational and academic stress, drinking too much alcohol, poor dietary habits, HIV, high cholesterol level and old age. etc. Anabolic steroid use by athletes has been associated with a large number of cardiovascular disorders. Anabolic steroids also increase muscle mass and physical strength, and are therefore used in sports and bodybuilding to increase strength or physique. Excessive use of anabolic steroids has been associated with the development of a reversible dilated cardiomyopathy and potentially severe heart failure and cardiac arrest. Anabolic steroids cause lipid profile abnormalities, such as increases in total cholesterol, triglyceride, and LDL, and decreases in HDL levels. High total cholesterol, high triglyceride levels and high low-density lipoprotein are associated with hardening of the coronary arteries and plaque build-up in the arteries.

### **Anabolic androgenic steroids**

Anabolic androgenic steroids (AAS) abuse can increase the risk of cardiovascular complications, including acute myocardial infarction. Anabolic steroids increase muscle mass and physical strength, and are therefore used in sports and bodybuilding to increase strength or physique.

Abuse of Anabolic androgenic steroids may increase the risk of cardiovascular complications, including acute myocardial infarction. Anabolic steroids increase muscle mass and physical strength, and are therefore used in sports and bodybuilding to enhance strength or physique [1,3,8,5,9]. Anabolic androgenic steroids are the most commonly used substances to improve an athlete's exercise performance and body image. Anabolic androgenic steroids (AAS) abuse has been reported in 11% of

adult gym users, 39% of bodybuilders and a staggering 67% of powerlifters [7,8,9,10]. Post-mortem studies of athletes using AAS have found infiltration of eosinophils into myocardial cells as well as destruction of myofibrils [22,23,34,39], endothelial dysfunction was also observed (Cunha et.al.2005). Several studies have described cases of acute myocardial infarction and thromboembolic vascular episodes in athletes using Anabolic androgenic steroids [18,19,20,21]. Anabolic androgenic steroids abuse has been associated with acute myocardial infarction and fatal ventricular arrhythmias [7,8,18,19]. Many Anabolic androgenic steroids users also abuse growth hormone (GH), the effect on myocardial hypertrophy being potentiated by concomitant use of GH [22,23,24,25].

### **Cardiac Risk factors and Anabolic steroids**

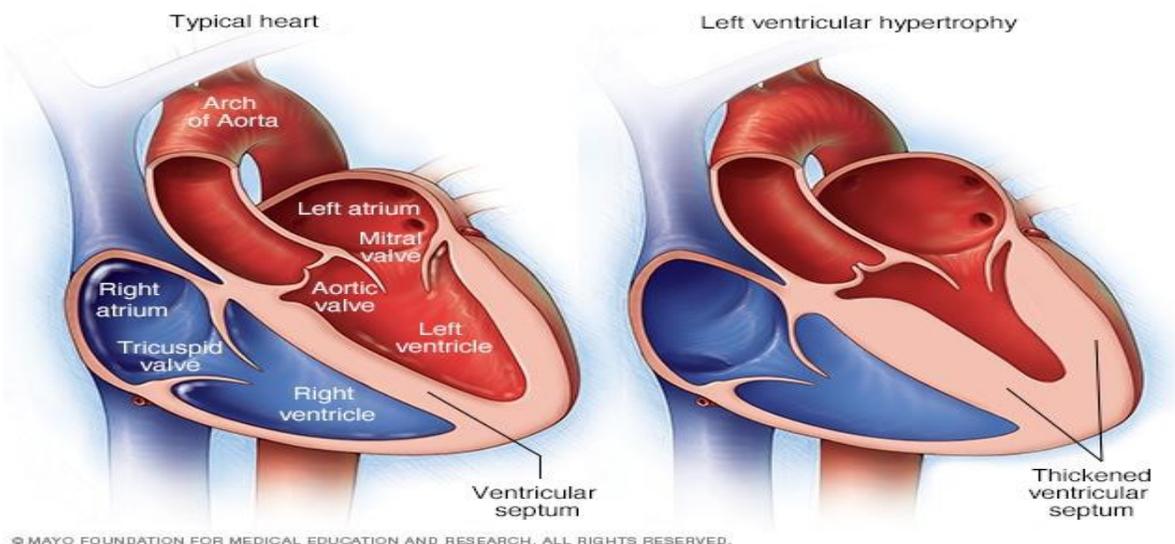
Several adverse effects of anabolic steroids are as follows :

#### **1. Deterioration of cardiac ejection fraction**

Ejection fraction is an indicator of how well your heart is working. Ejection fraction refers to how well your heart pumps blood [7,8,9]. This is the amount of blood pumped out of heart's lower chambers (ventricles) each time it contracts. A low ejection fraction usually means you have or are at risk for heart failure[23,34,43,]. The cardiac ejection fraction is the mass of fluid ejected from a chamber with each contraction. It may refer to the cardiac atrium, ventricle, pectoral or leg veins, although if unspecified it usually refers to the left ventricle of the heart[13,14,15]. The ejection fraction in a healthy heart ranges from 50% to 70%. With each heartbeat, your left ventricle pumps 50% to 70% of your blood to your body. The several research indicates the low cardiac ejection fraction due to long term misuses of Anabolic steroids by the athletes [2,10,11,12].

#### **2. Left ventricular hypertrophy :**

Left ventricular hypertrophy is a thickening of the wall of the main pumping chamber of the heart. This thickening can result in increased pressure within the heart and sometimes poor pumping action [3,29,30,31] . In the condition of left ventricular hypertrophy, the thickened heart wall may become rigid. The blood pressure in the heart increases. The changes make it harder for the heart to pump blood effectively. Eventually the heart may fail to pump with as much force as is needed High blood pressure is the most common cause of left ventricular hypertrophy. Long-term high blood pressure puts stress on the left side of the heart, causing it to become enlarged. According to the new research report. Anabolic androgenic steroid (AAS) abuse is associated with severe blood pressure (BP) elevation[33,34,35]. Long-term use of anabolic androgenic steroids (AAS) by athletes results in an increase in both systolic and diastolic blood pressure. Anabolic androgenic steroid (AAS) abuse is prevalent among competitive athletes and adverse effects on blood pressure (BP) and arterial stiffness can be substantial[36,38,39].



The above Figure prepared by the Mayo Foundation of Medical Education and Research shows a comparison of a normal heart and a heart with left ventricular hypertrophy

### **Lipid profile abnormalities**

Lipids are fatty compounds in the blood that perform a variety of functions in the human body. Lipids help move and store energy, absorb vitamins and make hormones. Excess of some lipids is harmful. [4,5,40,42]. Cholesterol is a lipid in blood. Cholesterol has two components, high-density lipoprotein (HDL) and low-density lipoprotein (LDL). High levels of low-density lipoprotein (LDL) cholesterol, triglycerides, and low levels of HDL cholesterol are associated with heart disease (5). Elevated levels of LDL cholesterol, often referred to as "bad" cholesterol, are associated with heart disease. LDL cholesterol can stick to the walls of the arteries, causing blockages or plaques [4,5,40,41,42]. As plaques build up, they reduce or block blood flow to the heart, which can result in a heart attack. In addition, high levels of triglycerides are also linked to heart disease as they can also lead to the formation of plaques in the arteries of the heart. Furthermore, Low levels of HDL cholesterol, commonly known as "good" or "healthy" cholesterol, can also increase the risk of heart disease. HDL cholesterol is involved in removing "bad" LDL cholesterol from the body [5,6,22,24,35,22]. Anabolic steroids have been shown to **increase the level of LDL cholesterol** and decrease the level of HDL cholesterol. The several research report indicates that, the misuse of Anabolic steroids by the athletes, have been shown to increase LDL cholesterol levels and reduce HDL cholesterol levels may increase the formation of plaques in coronary arteries in the heart, which responsible for heart attack or sudden death. Many research reports suggest that, abuse of anabolic steroids by athletes can increase the formation of plaques in the coronary arteries in the heart by raising the level of LDL cholesterol and lowering the level of HDL cholesterol, which can lead to heart attack or sudden cardiac death [5,6,22,24,35,22,23,25,27,28,29].

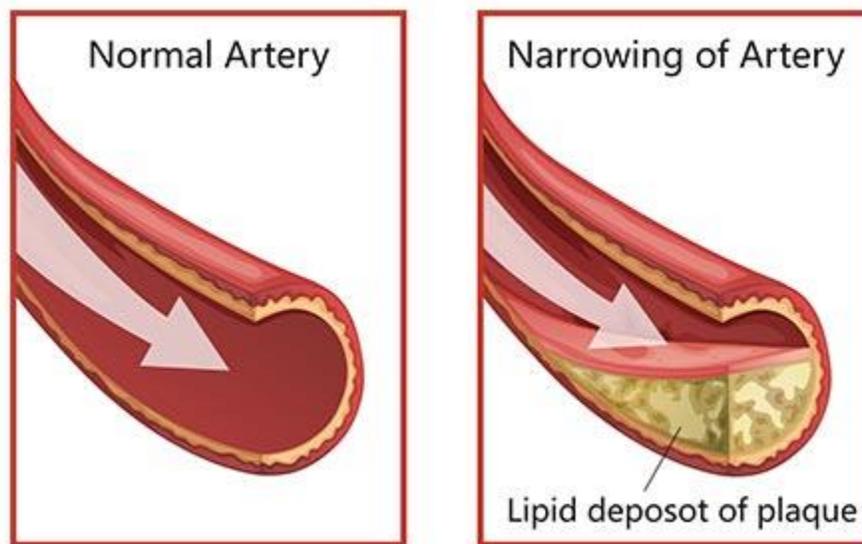


Figure 1. Drawing of how the coronary arteries get clogged up with plaque  
This diagram is derived from Wikipedia.

### **Sudden cardiac arrest**

Sudden cardiac arrest is the sudden stoppage of all activity of the heart due to an irregular heart rhythm. The person becomes unconscious. Sudden cardiac arrest can lead to death. Anabolic androgenic steroids (AAS) used by athletes to improve physical performance have been implicated in acute myocardial infarction and sudden cardiac death [3,4,5,6,7,9].

### **REFERENCES**

- [1] Thygesen K, Alpert JS, White HD, Joint ESC/ACCF/AHA/WHF Task Force for the Redefinition of Myocardial Infarction. Jaffe AS, Apple FS, Galvani M, Katus HA, Newby LK, Ravkilde J, Chaitman B, Clemmensen PM, Dellborg M, Hod H, Porela P, Underwood R, Bax JJ, Beller GA, Bonow R, Van der Wall EE, Bassand JP, Wijns W, Ferguson TB, Steg PG, Uretsky BF, Williams DO, Armstrong PW, Antman EM, Fox KA, Hamm CW, Ohman EM, Simoons ML, Poole-Wilson PA, Gurfinkel EP, Lopez-Sendon JL, Pais P, Mendis S, Zhu JR, Wallentin LC, Fernández-Avilés F, Fox KM, Parkhomenko AN, Priori SG, Tendera M, Voipio-Pulkki LM, Vahanian A, Camm AJ, De Caterina R, Dean V,

- Dickstein K, Filippatos G, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL, Morais J, Brener S, Harrington R, Morrow D, Lim M, Martinez-Rios MA, Steinhilb S, Levine GN, Gibler WB, Goff D, Tubaro M, Dudek D, Al-Attar N. Universal definition of myocardial infarction. *Circulation*. 2007 Nov 27;116(22):2634-53. [[PubMed](#)].
- [2] Rasmussen JJ, Schou M, Madsen PL, Selmer C, Johansen ML, Hovind P, Ulriksen PS, Faber J, Gustafsson F, Kistorp C. Increased blood pressure and aortic stiffness among abusers of anabolic androgenic steroids: potential effect of suppressed natriuretic peptides in plasma? *J Hypertens*. 2018 Feb;36(2):277-285. doi: 10.1097/HJH.0000000000001546. PMID: 28863033.
- [3] (<https://www.mayoclinic.org/diseases-conditions/left-ventricular-hypertrophy/symptoms-causes/syc-20374314#:~:text=Left%20ventricular%20hypertrophy%20is%20a,cause%20is%20high%20blood%20pressure.>).
- [4] (<https://meridian.allenpress.com/aplm/article/125/2/253/452935/Anabolic-Steroid-Abuse-and-Cardiac-Sudden-Death>
- [5] (<https://my.clevelandclinic.org/health/body/24425lipids#:~:text=Lipids%20are%20fatty%20compounds%20that,of%20some%20lipids%20is%20harmful>).
- [6] (<https://www.drugs.com/medical-answers/blood-lipids-linked-heart-disease-3515530/#:~:text=High%20levels%20of%20LDL%20cholesterol%2C%20often%20called%20the%20E2%80%9Cbad%20E2%80%9D,are%20associated%20with%20heart%20disease.>).
- [7] Perry HM, Wright D, Littlepage BN. Dying to be big: a review of anabolic steroid use. *Br J Sports Med*. 1992; **26**: 259-61.
- [8] Curry LA, Wagman DF. Qualitative description of the prevalence and use of anabolic androgenic steroids by United States powerlifters. *Percept Mot Skills*. 1999; **88**: 224-33.
- [9] Montisci M, El Mazloum R, Cecchetto G, Terranova C, Ferrara SD, Thiene G, et al. Anabolic androgenic steroids abuse and cardiac death in athletes: morphological and toxicological findings in four fatal cases. *Forensic science international*. 2012; **217**: e13-8.
- [10] Fineschi V, Riezzo I, Centini F, Silingardi E, Licata M, Beduschi G, et al. Sudden cardiac death during anabolic steroid abuse: morphologic and toxicologic findings in two fatal cases of bodybuilders. *International journal of legal medicine*. 2007; **121**: 48-53.
- [11] Thiblin I, Lindquist O, Rajs J. Cause and manner of death among users of anabolic androgenic steroids. *Journal of forensic sciences*. 2000; **45**: 16-23.
- [12] Montisci M, El Mazloum R, Cecchetto G, Terranova C, Ferrara SD, Thiene G, et al. Anabolic androgenic steroids abuse and cardiac death in athletes: morphological and toxicological findings in four fatal cases. *Forensic science international*. 2012; **217**: e13-8.
- [13] Far HR, Agren G, Thiblin I. Cardiac hypertrophy in deceased users of anabolic androgenic steroids: an investigation of autopsy findings. *Cardiovascular pathology : the official journal of the Society for Cardiovascular Pathology*. 2012; **21**: 312-6.
- [14] Baggish AL, Weiner RB, Kanayama G, Hudson JI, Picard MH, Hutter AM, Jr., et al. Long-term anabolic-androgenic steroid use is associated with left ventricular dysfunction. *Circulation Heart failure*. 2010; **3**: 472-6
- [15] Deligiannis A, Björnstad H, Carre F, et al. ESC study group of sports cardiology position paper on adverse cardiovascular effects of doping in athletes. *Eur J Cardiovasc Prev Rehabil*. 2006; **13**: 687-694.
- [16] Basaria S. Androgen abuse in athletes: detection and consequences. *J Clin Endocrinol Metab*. 2010; **95**: 1533-1543.
- [17] Varró A, Baczkó I. Possible mechanisms of sudden cardiac death in top athletes: a basic cardiac electrophysiological point of view. *Pflugers Arch* 2010; **460**: 31-40.
- [18] Deligiannis A, Kouidi E. Health side effects of doping substances - cardiovascular system. *Manual of International Symposium "Biomedical side effects of Doping"*; Munich 2006, pp 45-54.
- [19] Riezzo I, De Carlo D, Neri M, Nieddu A, Turillazzi E, Fineschi V. Heart disease induced by AAS abuse, using experimental mice/rats models and the role of exercise-induced cardiotoxicity. *Mini Rev Med Chem*. 2011; **11**: 409-424.
- [20] Cunha TS, Moura MJ, Bernardes CF, Tanno AP, Marcondes FK. Vascular sensitivity to phenylephrine in rats submitted to anaerobic training and nandrolone treatment. *Hypertension*. 2005; **46**: 1010-1015.
- [21] Basaria S. Androgen abuse in athletes: detection and consequences. *J Clin Endocrinol Metab*. 2010; **95**: 1533-1543.
- [22] Dickerman RD, Schaller F, McConathy WJ. Left ventricular wall thickening does occur in elite power athletes with or without anabolic steroid Use. *Cardiology*. 1998; **90**: 145-148
- [23] Kouidi E, Anifanti M, Kaltsatou A, Deligiannis A. Effects of androgenic anabolic steroids use on left ventricular anatomy and function in strength-trained athletes. *Proceedings ESC ties in athletes using anabolic-androgenic steroids*. *Int J Cardiol*. 2007; **114**: 132-134.



- [24] Salke RC, Rowland TW, Burke EJ. Left ventricular size and function in body builders using anabolic steroids. *Med SciSports Exerc.* 1985; 17: 701-704.
- [25] Deligiannis A, Mandroukas K. Non-invasive cardiac evaluation of weight-lifters using anabolic steroids. *Scand J Med SciSports* 1992; 3: 37-40.
- [26] Zuliani U, Bernardini B, Catapano A, Campana M, Cerioli G, Spattini M. Effects of anabolic steroids, testosterone, and HGH on blood lipids and echocardiographic parameters in body builders. *Int J Sports Med.* 1989; 10: 62-66.
- [27] Thompson PD, Sadaniantz A, Cullinane EM, et al. Left ventricular function is not impaired in weight-lifters who use anabolic steroids. *J Am CollCardiol.* 1992; 19: 278-282.
- [28] Palatini P, Giada F, Garavelli G, et al. Cardiovascular effects of anabolic steroids in weight-trained subjects. *J ClinPharmacol.* 1996; 36: 1132-1140.
- [29] Hartgens F, Cheriex EC, Kuipers H. Prospective echocardiographic assessment of androgenic-anabolic steroids effects on cardiac structure and function in strength athletes. *Int J Sports Med.* 2003; 24: 344-351.
- [30] Pearson AC, Schiff M, Mrosek D, Labovitz AJ, Williams GA. Left ventricular diastolic function in weight lifters. *Am J Cardiol.* 1986; 58: 1254-1259.
- [31] Urhausen A, Albers T, Kindermann W. Are the cardiac effects of anabolic steroid abuse in strength athletes reversible? *Heart.* 2004; 90: 496-501.
- [32] Sachtleben TR, Berg KE, Elias BA, Cheatham JP, Felix GL, Hofschire PJ. The effects of anabolic steroids on myocardial structure and cardiovascular fitness. *Med Sci Sports Exerc.* 1993; 25: 1240-1245.
- [34] Nottin S, Nguyen LD, Terbah M, Obert P. Cardiovascular effects of androgenic anabolic steroids in male bodybuilders determined by tissue Doppler imaging. *Am J Cardiol.* 2006; 97: 912-915.
- [35] Krieg A, Scharhag J, Albers T, Kindermann W, Urhausen A. Cardiac tissue Doppler in steroid users. *Int J Sports Med.* 2007; 28: 638-643.
- [36] D'Andrea A, Caso P, Salerno G, et al. Left ventricular early myocardial dysfunction after chronic misuse of anabolic androgenic steroids: a Doppler myocardial and strain imaging analysis. *Br J Sports Med.* 2007; 41: 149-155.
- [37] Turillazzi E, Perilli G, Di Paolo M, Neri M, Riezzo I, Fineschi V. Side effects of AAS abuse: an overview. *Mini Rev Med Chem.* 2011; 11: 374-389.
- [38] Ahlgrim C, Guglin M. Anabolics and cardiomyopathy in a bodybuilder: case report and literature review. *J Card Fail.* 2009; 15: 496-500.
- [39] Nascimento JH, Medei E. Cardiac effects of anabolic steroids: hypertrophy, ischemia and electrical remodelling as potential triggers of sudden death. *Mini Rev Med Chem.* 2011; 11: 425-429.
- [40] Hourigan LA, Rainbird AJ, Dooris M. Intracoronary stenting for acute myocardial infarction (AMI) in a 24-year-old man using anabolic androgenic steroids. *Aust N Z J Med* 1998; 28: 838-839.
- [41] Wysoczanski M, Rachko M, Bergmann SR. Acute myocardial infarction in a young man using anabolic steroids. *Angiology.* 2008; 59: 376-378.
- [42] Deligiannis A, Björnstad H, Carre F, et al. ESC study group of sports cardiology position paper on adverse cardiovascular effects of doping in athletes. *Eur J Cardiovasc Prev Rehabil.* 2006; 13: 687-694.
- [43] Achar S, Rostamian A, Narayan SM. Cardiac and metabolic effects of anabolic-androgenic steroid abuse on lipids, blood pressure, left ventricular dimensions, and rhythm. *Am J Cardiol.* 2010; 106: 893-901.