SUDDEN CARDIAC DEATH IN YOUNG ADULTS

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Abstract

"Sudden cardiac death in young adults is the most dramatic and emotional moment of a persons life". The sudden cardiac death (SCD) is the major cause of death in adults. The commonest cause of sudden cardiac death is coronary artery disease accounting for as many as 80% of cases, followed by cardiomyopathy in 10 to 15 %. Other causes account for 5 to 10 % of cases.

Coronary artery disease is far less common cause of sudden cardiac death in young adults although it accounts for majority of deaths above 35 years. More recent studies indicate that the atherosclerotic process begins during childhood. Sudden deaths due to coronary artery disease in young adults are rarely reported.

Here we are reviewing 11 cases of sudden cardiac death due to coronary atherosclerosis in young adults aged between 21 to 34 years, autopsied during a period of 2 year, from January 2011 to December 2012. With these cases we have tried to review the literature and discuss the SCD in young adults. Role of plaque disruption, plaque hemorrhage and thrombosis in acute coronary syndrome has been stressed and tried to relate with SCD in young persons. Importance of personal history, family history, meticulous autopsy and role of histopathological examination is of paramount importance in arriving at the final cause of death.

Keywords: Sudden cardiac death, Young Adult, Coronary Plaque

Introduction

Cardiovascular diseases are a major cause of death in developed and developing countries, with a significant medical, social, and economic impact.[1]

The incidence of coronary artery disease has doubled in Indians during the past three to four decades considering the variation in racial, dietary and lifestyle patterns in our population. It will soon emerge as the single largest disease accounting for nearly one-third of all deaths in India. The number of deaths due to coronary artery disease in India is projected to increase from 1.591 million in year 2000 to 2.034 million by year 2010 (WHO report 1999).[2]

A generally accepted definition of Sudden Cardiac Death (SCD) is *natural death due to cardiac causes*, heralded by abrupt loss of consciousness within *1 hour* of the onset of acute symptoms, in an individual who may have known *preexisting* heart disease but in whom the *time* and *mode* of death are *unexpected.* Among adolescents and young adults, the incidence of SCD is approximately 1 per 1, 00, 000 population per year or 0.001 percent per year.[3]

Although coronary artery disease (CAD) accounts for a majority of these deaths across all

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ages, many other etiologies contribute to this problem when it occurs in the young (age < or = 35 years), where coronary artery disease is far less common.[4]

CAD is the major predisposing structural abnormality in 80-85 % of SCD. Davis reported that in almost 2/3 of these deaths, triple vessel disease is present with 75% or more stenosis at any one point. Ventricular hypertrophy per se is an independent mortality risk. This may be an additional factor when acute or chronic ischemia coexists.[5]

Although only a single major coronary epicardial trunk may be affected, two or all three—left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA)—are often involved. Clinically significant stenosing plaques may be located anywhere within these vessels but tend to predominate within the first several centimeters of the LAD and LCX and along the entire length of the RCA. Sometimes the major secondary epicardial branches are also involved (i.e., diagonal branches of the LAD, obtuse marginal branches of the LCX, or posterior descending branch of the RCA), but atherosclerosis of the intramural branches is rare. However, as mentioned above, the onset of symptoms and prognosis of IHD depend not only on the extent and severity of fixed, chronic anatomic disease, but also critically on dynamic changes in coronary plaque morphology.[6]

Genetic factors contribute to the risk of SCD. In one sense, they contribute to familial predisposition to Coronary Heart Disease (CHD) and its expression as acute coronary syndromes. A family history of CHD is known to increase the risk of premature death.[2,6]

The etiology of atherosclerosis causing coronary heart disease is complex. Pathogenesis includes hemodynamic and thrombotic factors, high levels of cholesterol, smoking, lifestyle, and intrinsic factors of the arterial wall. An excessive inflammatory response to various insults to the endothelium and smooth muscle of the arterial wall results in lymphoproliferation and injury. A large number of growth factors, cytokines, and molecules are involved in this process.[7,8]

Current studies indicate that atherosclerosis begins to develop in childhood, with fatty streaks grossly visible in the aortas of children from 3 years of age.[9] These findings have changed the model of atherosclerosis as a chronic degenerative disease of elderly patients to a model of subclinical chronic inflammatory disease starting in childhood and influenced by known risk factors, autoimmune reactions, and more recently by infectious agents such as Chlamydia pneumoniae which are currently the focus of numerous studies.[10]

Interestingly the expression of disease from elderly individuals with extensive coronary atherosclerosis who have never had a symptom, to the previously asymptomatic young adult in whom modestly obstructive disease comes unexpectedly to medical attention as a result of acute MI or sudden cardiac death. The reasons for clinical heterogenous expression of the disease are complex, but precipitous outcome will largely depend on the pathologic basis of the so-called acute coronary syndromes of Ischemic Heart Disease (IHD) (comprising unstable angina, acute MI, and sudden death). The acute coronary syndromes are frequently initiated by an unpredictable and abrupt conversion of a stable atherosclerotic plaque to an unstable and potentially life-threatening atherothrombotic lesion through superficial erosion, ulceration, fissuring, rupture, or deep hemorrhage, usually with superimposed thrombosis. For purposes of simplicity, this spectrum of alteration in atherosclerotic lesions will be termed either plaque disruption or acute plaque change.[6]

Material and Methods

Total number of cases autopsied in our institute during period between January 2011 to December 2012 was 1020 cases. Out of 1020 cases 50 cases of sudden cardiac deaths were

reported. 11 cases of sudden cardiac death aged between 21 to 34 years were selected for study. All 11 cases heart were submitted for histopathology examination and reported by pathologist.

Results

All 11 cases studied were of male sex and age group was between 21-34yr, Mean Age was 27.36 years. 4 cases had past history of chest pain and syncopal attacks. 2 cases had family history of sudden cardiac death.

Gross and histopathological findings

Left main coronary artery showed atheroma with thrombus in 2 cases and 1 case had plaque hemorrhage and 2 cases showed significant and 1 case showed mild atheromatous thickening. Other 5 cases were patent.

Left anterior descending artery was significantly narrowed by atheroma and thrombus formation in 3 cases, plaque hemorrhage with thrombus formation noted in 2 cases, 1 case showed plaque hemorrhage alone, 2 cases showed significant atheromatous narrowing and other 2 cases showed mild atherosclerosis. In 1 case lumen was patent but of smaller caliber.

Right coronary artery was patent in 7 cases, 2 cases showed significant atherosclerotic narrowing, 1 case showed moderate and other 1 showed mild atherosclerosis of the lumen.

Aorta showed extensive atherosclerotic plaques in 2 cases, 6 cases showed mild atherosclerosis and 3 cases were unremarkable.

Out of 11 cases, 6 cases showed more than one vessel involvement by atherosclerosis. Most commonly affected vessel is left anterior descending artery -10 cases, followed by left coronary trunk-6 cases, right coronary artery-4 cases and then left circumflex-2 cases. Left ventricular hypertrophy was present in 2 cases and mitral valve thickening in 2 cases.

Site of occurrence of atherosclerosis is most frequent at first few centimeters of origin of LAD (10 cases) followed by whole of left coronary trunk (6 cases) then initial few centimeters of origin of RCA (4 cases) and initial few centimeters of origin of LCX (2 case).

Discussion

Coronary heart disease is assuming serious dimension in developing countries. It is expected to be the single most important cause of death in India by the year 2015.[2]

The age of getting heart attacks has fallen from 40 to 30 in the last decade, revealed the study, 'Breaking the unbreakable plateau'. The CSI survey covered 15,000 heart patients in Delhi to understand the change in pattern of heart ailments and heart attacks in India. It found a 50 percent rise in the number of women suffering from cardiovascular diseases, apart from an equal rise of patients in the 20-40 age group. Sri Jayadeva Heart Watch, a study conducted by Sri Jayadeva Institute of Cardiovascular Sciences and Research (SJICR) last year, found that 25% of its patients were below the age of 40 years, of which 10% were women[11.]

Data from postmortem examinations of SCD victims parallel the clinical observations on the prevalence of CHD as the major structural etiologic factor. More than 80% of SCD victims have pathological finding of CHD. The pathologic description often includes a combination of long standing, extensive atherosclerosis of the epicardial coronary arteries and unstable coronary artery lesions, which include various permutations of fissure or ruptured plaques, platelet aggregates, hemorrhage, and thrombosis.[3]

In above studied 11 cases all are of male sex and average age is 27.36 years. Recent clinical study findings showed younger age group is at substantial risk of SCD11. 4 cases have past clinical history of chest pain and syncopal attacks and 2 cases have family history of SCD.[2,6]

Left anterior descending artery was most commonly involved (all 11 cases) vessel followed by left main coronary then right coronary and left circumflex artery.

In our study plaque hemorrhage and atheromatous thrombus formation seen in 6 cases. It is widely accepted that rupture of vulnerable atherosclerotic plaque leads to acute coronary syndromes.[12]

Acute coronary syndromes manifest as unstable angina, acute MI, and (in many cases) sudden cardiac death is precipitated by abrupt plaque change followed by thrombosis. Most often, the initiating event is disruption of previously only partially stenosing plaques with rupture/fissuring, exposing the highly thrombogenic plaque constituents; erosion/ulceration, exposing the thrombogenic subendothelial basement membrane to blood or hemorrhage into the atheroma, expanding its volume.[6]

The important characteristics of an unstable or vulnerable plaque are a large lipid core, a thin fibrous cap and many inflammatory cell including macrophages. The fibrous cap is the only structure separating the blood component containing coagulation factors from thrombogenic material in the lipid core. When such a fibrous cap ruptures, it allows contact of these coagulation factors with tissue factors and promotes thrombosis.[13]

The more the number of vulnerable plaques and high grade inflammation, more the risk of sudden cardiac death.[14,15]

The events that trigger abrupt changes in plaque configuration and superimposed thrombosis are complex and poorly understood. Influences, both intrinsic (e.g., plaque structure and composition) and extrinsic (e.g., blood pressure, platelet reactivity) are important. Acute alterations in plaque imply the inability of a plaque to withstand mechanical stresses.[6]

Studies examining the histopathological aspects of early and advanced atherosclerotic lesions have emphasized the crucial role of macrophages in the formation of foam cells and fatty streaks. Atherosclerotic lesions are considered advanced when there is accumulation of cells, lipids, and matrix components including minerals, and when they are associated with structural disorganization, repair and thickening of the intima, and deformity of the arterial wall.[16,17]

It is now recognized that the preexisting culprit lesion in patients who develop myocardial infarction and other acute coronary syndromes is not necessarily a severely stenotic and hemodynamically significant lesion prior to its acute change. Pathologic and clinical studies show that plaques that undergo abrupt disruption leading to coronary occlusion often are those that previously produced only mild to moderate luminal stenosis. Approximately two thirds of plaques that rupture with subsequent occlusive thrombosis caused occlusion of only 50% or less before plaque rupture, and 85% had initial stenosis less than 70%.[6]

Vasoactive events including coronary artery spasm, lead to transient ischemia followed by reperfusion injury. This produces electrical, mechanical and biochemical dysfunction. However the important determinant is the susceptible myocardium. When the susceptible myocardium is present, disturbances in autonomic nervous system, electrolyte imbalance, drugs and electrical instability can serve as triggers for potentially lethal arrhythmias. Ventricular fibrillation occurs in 70% cases of SCD and electromechanical dissociation or asystole occurs in the remaining cases.[5]

Large number of asymptomatic adults in the industrial world has a real but unpredictable risk of a catastrophic coronary event. Regrettably, it is presently impossible to reliably predict plaque disruption or subsequent thrombosis in an individual patient.[6]

"Not only college students, even working professionals have adopted the ways of the modern lifestyle, and this has proved to be the instigator of heart diseases. Junk food joints have become hangout points amongst college students and young professionals, who go for a quick bite to save time," says the study.[11]

Conclusion

Review of these cases bring into question whether present prevention strategies are sufficient and reinforce the need to extend prevention to younger ages. Dietary changes, smoking free society, reducing mean population blood pressure levels, regular physical activity are specific interventions to prevent CHD.

The role of genetic testing, both in living affected individuals and in the setting of a 'molecular autopsy', is emerging as a key factor in early diagnosis of an underlying cardiovascular genetic disorder. Understanding the genetic basis of SCD, investigating the molecular mechanisms that lead from the gene defect to the clinical phenotype, and elucidating the specific environmental triggers for SCD, will most likely lead to further key improvements in the prevention of SCD in the young.

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Table: Showing salient findings of 11 cases of sudden cardiac deaths.

Sl.. No	Age	Sex	Past H/O Chest Pain	Family H/O SCD	Left Main Coronary	Left Anterior Descending Artery	Left Circumflex Artery	Right coronary artery	Aorta Atherosclerosis	LVH /IVSH	Valves	H/O Myocardial Infarction
1	26	M	Present	Present	Patent	Plaque Hemorrhage and Thrombus	Patent	Patent	Mild	Present	UR	Old LV, IVS
2	24	M	Present	Present	Patent	Atheroma with Thrombus	Patent	Patent	UR	UR	UR	Nil
3	21	M	Absent	Absent	Thrombus at ostia	Atheromatous narrowing	Patent	Patent	Extensive,	UR	Fibrosis	Nil
4	25	M	Absent	Absent	Plaque hemorrhage	Plaque hemorrhage	Patent	Patent	UR	UR	Fibrosis	Nil
5	30	M	Absent	Absent	Atheroma with Thrombus	Atheroma with Thrombus	Patent	Patent	Extensive	Present	UR	Nil
6	22	M	Absent	Absent	Atheroma tous Narrowing	Mild Atheromatous Narrowing	Atheroma tous Narrowing	Atheromatous Narrowing	UR	UR	UR	Nil
7	34	M	Absent	Absent	Mild Atheromatous Narrowing	Mild Athero matous Narrowing	Patent	Complete atheroma thickening	Mild	UR	Fibrosis	Nil
8	32	M	Present	Absent	Significatheroma narrowing	Patent but smaller caliber	Patent	Patent	Mild	UR	UR	Nil
9	27	M	Absent	Absent	Patent	Plaque Hemorrage and Thombus	Patent	Patent	Mild	UR	UR	Nil
10	26	M	Absent	Absent	Patent	Atheromatous Narrowing	Mild Atheromatous Narrowing	Mild Atheromatous Narrowing	Mild	UR	UR	Nil
11	34	M	Present	Absent	Patent	Atheroma with thrombus	Patent	Moderate atheromatous narrowing	Mild	UR	UR	Nil

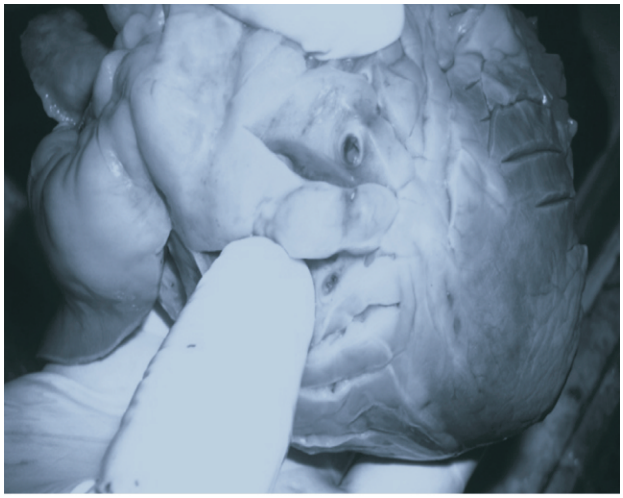

Fig. 1 Showing 80 to 90% block of left anterior Descending coronary Artery with plaque hemorrhage and thrombus formation.

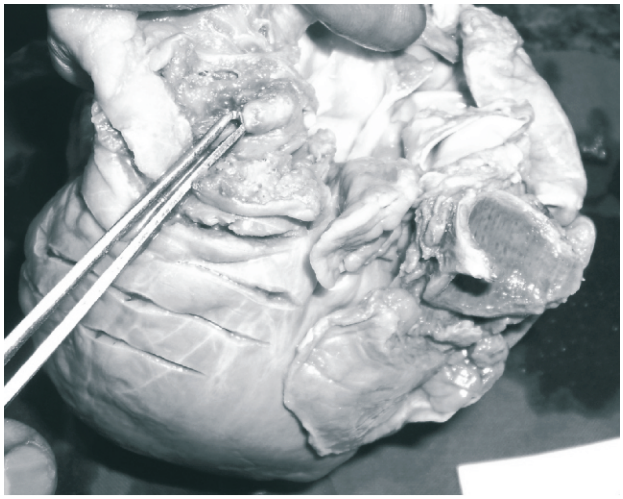

Fig.2 showing complete occlusion of left anterior descending coronary artery with thickening and calcification.

Fig 3. Shows complete block of right coronary artery with thickening.

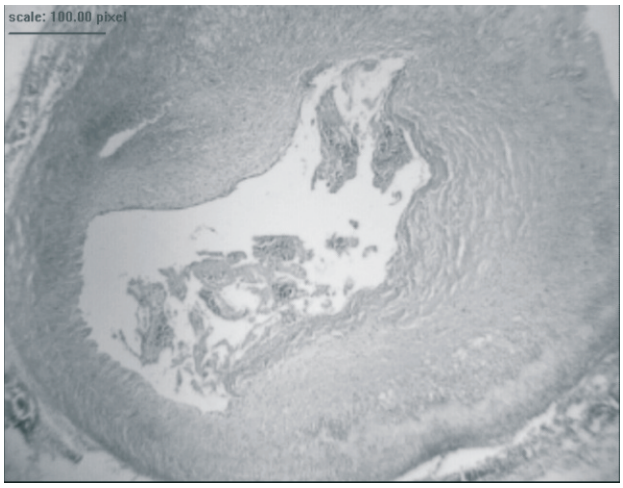

Fig 4. Low power view showing coronary plaque with thrombus formation narrowing lumen. H & E Stain

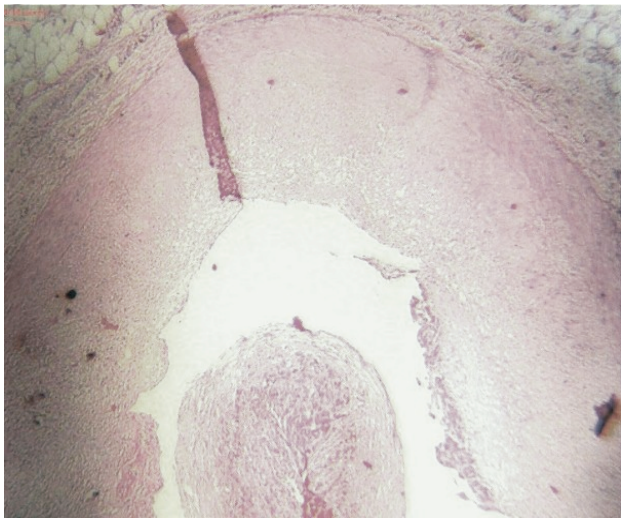

Fig. 5 Low power view showing superadded thrombus, occluding the lumen of coronary.

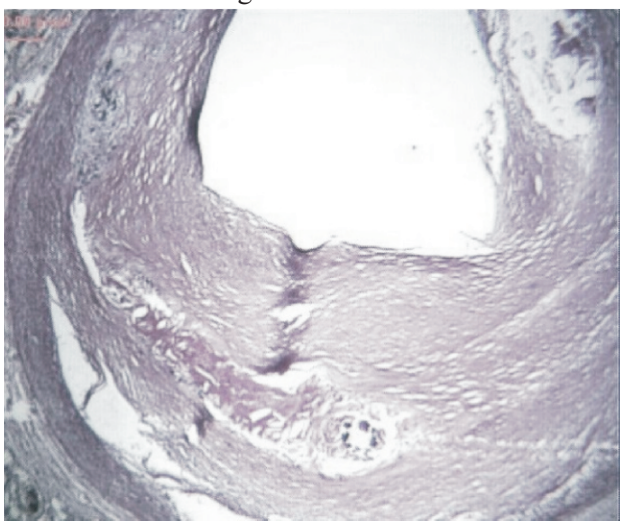

Fig 6. Showing coronary atheromatous plaque narrowing the lumen..