Original Research Article

Autopsy Findings in Sudden Cardiac Deaths: Study in Medicolegal Autopsies

Dr. Shashank Tyagi[1], Dr. Rajesh B. Sukhadeve[2], Dr. Harish M. Pathak[3]
[1]Post Graduate Student (MD), Department of Forensic Medicine and Toxicology, Seth Gordhandas Sunderdas Medical College, King Edward Memorial Hospital, Acharya Donde Marg, Parel, Mumbai- 400012, India
[2]Additional Professor, Department of Forensic Medicine and Toxicology, Dr. R. N. Cooper Medical College and General Hospital, Juhu, Mumbai, India
[3]Professor and Head, Department of Forensic Medicine and Toxicology, Seth Gordhandas Sunderdas Medical College, King Edward Memorial Hospital, Mumbai, India

*Corresponding author
Dr Shashank Tyagi.
Email: shankstag011@yahoo.in

Abstract: The term sudden cardiac death (SCD) pertains to an unexpected death from cardiac causes within a short time period and has been described throughout history. The aim of the study was to evaluate the data with respect to incidences, epidemiological aspects, impact of risk factors, estimate the survival time and cause of death in relation to sudden natural cardiac death victims. This study was conducted on 137 victims of sudden cardiac death brought to Seth G.S. Medical College & KEM Hospital, Mumbai, India during period from January 2014 to July 2015. The incidence of sudden natural cardiac deaths among the total medico legal autopsies is 6.26%, with most affected age group of 51-60 years. The male to female ratio was 4.07:1. Smoking and alcohol habits outnumbered the other risk factors. Majority of the deaths were within 1-6 hours of onset of symptoms i.e. in 85 (62.04%) cases. Ischemic heart disease contributed maximum number of deaths i.e. 126 cases (91.97%). Out of which, 81 (59.12%) cases showed critical coronary stenosis. Maximum number of coronary arteries were blocked within 2 cm of origin of the artery i.e. 60 (74.07%), most commonly seen in left anterior descending artery (LAD) 38 cases (46.91%). Cardiovascular pathology is a major contributor for sudden death. There is a need for defining and initiating preventive cardiovascular health measures to meaningfully reduce the incidence of SCD.
Keywords: Sudden cardiac death, ischemic heart disease, critical coronary stenosis, Medico legal autopsies.

INTRODUCTION

According to WHO, sudden death are sudden and unexpected death of a person is usually seen within 24 hours of onset of symptoms. Most of time, these deaths are resulted within an hour of onset and most of patients, when brought to the hospital are already dead. The most widely accepted definition of sudden death is – A death which is not known to be caused by any trauma, poisoning or violent asphyxia and where death occurs all of a sudden or within twenty-four hours of the onset of terminal symptoms, which may be totally different from the symptoms which the patient was having so long. Thus, if the cause of death is known to be unnatural one, it can't be termed as sudden death. Natural death means the death occurring due to the natural disease; in this regard the death is not intended or attempted. Sudden death is not necessarily unexpected and unexpected death is not necessarily sudden, but very often the two combinations coexist [1].

Sudden deaths can be classified into two groups: The first group in which the autopsy of death reveals a lesion, which is not compatible with life because of its nature, site and extent, for example the rupture of an aortic aneurysm. The second group is having a large proportion of deaths from natural causes. Some lesion is found at autopsy which may have caused death but which is also compatible with continued life e.g. arteriosclerosis of coronary arteries. In these cases the failure to detect any other causes of death is presumptive evidence that the lesion was responsible for the death but is not conclusive proof. Therefore, the clinical history is often of value in determining the probable cause of death in such circumstances [2].

The rate of SND in cardiovascular system is approximately 45-50%, followed by central nervous system 15-20 %, respiratory system 15-25 %, gastro-intestinal system 5-10 %, genito-urinary system 2-5 %, infectious 0.15 % and miscellaneous 0.5-2 %6. The causes are mainly a function of age [3, 4].

Forensic pathologists deal not only with criminal, accidental and suicidal deaths, but also with a wide range of deaths from natural causes. Many of these deaths are sudden, unexpected, clinically unexplained or obscure; even though there need be no criminal element in their causation [5]. Such death may occur during emotional excitement, mental tension, and strenuous physical work or simply while resting or sleeping in the bed. When the death occurs without the presence of other persons, suspicion of homicidal death has to be clarified. Precipitating factor may be a blow or a fall. In such cases, a medical practitioner should not certify the cause of death without holding the post-mortem examination, even if there is strong evidence of disease. Often after autopsy, an apparent unnatural death may turn out to be natural and vice versa [6].

It was reported that concordance between clinical and pathological causes of death are moderate, and the autopsy still provides a very important procedure for evaluating causes of deaths. Over one fifth of clinically unexpected autopsy findings can be correctly diagnosed only by histological examination. Autopsy and particularly autopsy histology are still the most accurate method of determining the cause of death and auditing accuracy of clinical diagnosis, diagnostic tests and death certification [7]. However, autopsy findings and clinical examinations may not be enough to evaluate accurate and consistent diagnosis and reporting of the cause of death. Sudden adult deaths may remain sometimes as an enigma after a complete autopsy [8]. These autopsies may also be a valuable source for epidemiological information in addition to providing valuable information to the deceased's immediate family [9-13].

Sudden natural cardiac deaths undoubtedly constitute a significant portion of deaths which undergo autopsy for investigation of death. Therefore, this study is carried out to determine the present scenario of sudden death in society. It will help to determine the cause and manner of death and helps to reveal important data for judicial justice system. Periodical publication of statistical data of sudden natural death provide an insight to society about the risk factors and helps in modifying the lifestyle to live a healthy long life.

The aim of the study was to evaluate the data with respect to:
- Incidences of sudden natural cardiac death victims.
- Epidemiological aspects of sudden natural cardiac death victims.
- Impact of risk factors in relation to sudden natural cardiac death victims.
- Estimate the survival time in cases of sudden cardiac death victims.
- Cause of death in sudden natural death victims.
- Medico legal aspects of sudden death.

MATERIAL AND METHODS

The study was conducted in the Department of Forensic Medicine and Pathology of Seth G.S. Medical College & KEM Hospital, Mumbai, India during period from January 2014 to July 2015.

All cases, irrespective of age groups and sex, who died suddenly and/or unexpectedly and brought to this institute for post-mortem examination, were studied.
Criteria for selection of cases were as follows:

Inclusion criteria
1. The cases, which were died within 24 hours of onset of terminal symptoms of natural disease and then brought to our hospital, for post-mortem examination.
2. The cases which were brought in casualty in unconscious state and were brought to institution for post-mortem examination with the manner of death either natural or not known and the cause of which subsequently on post-mortem examination, turned out to be sudden natural were included.
3. The cases which were belonged to only cardiovascular system after post-mortem examination.

Exclusion criteria
1. All cases of unnatural deaths were not included in this study.
2. The cases where cause of death turned out to be unnatural after the post-mortem examination.
3. The cases where cause of death remained obscure even after detailed post-mortem gross examination; histopathological, toxicological, microbiological, virological screening investigations were not included.
4. All natural deaths where duration between onset of symptoms and death is more than 24 hrs.
5. Deaths related to Non-cardiac origin.

OBSERVATION
During this period 2187 autopsies were conducted, out of which, 282 cases (12.89 %) were of sudden natural death and out of that, 137 cases (48.58 %) were of cardiovascular system.

Among these 137 cases of sudden cardiac deaths,110 cases (80.29%) were male and 27 (19.71%) were female. The male to female ratio was 4.07:1.The most affected age group among victims was of 51-60 years (39) closely followed by 61-70 years (31) cases as shown in figure no. 1.

Majority of the victims were belonging to Industry workers i.e. 63 cases (45.99 %), followed by retired person (>60 years) i.e. 44 cases (32.17%) by occupation as shown in Table no. 1.

The highest numbers of victims were observed in normally nourished 107 (78.10%) cases, followed by overweight 20 (14.60%) cases. The least number 10 (7.30%) was found in underweight persons as shown in figure no. 2.

Cases were classified according to Body mass index (BMI). A BMI from 18.5 up to 24.99 may indicate optimal weight i.e. normal nourished, BMI lower than 18.5 suggests the person is underweight, a number above than 25 may indicate the person is overweight.

Most of the cases of sudden natural cardiac deaths, i.e. 94 cases (68.61%) took place when the deceased was in his/her home, followed by public place 30 cases (21.90%), on duty 12 cases (8.76%) and road side 1 case (0.73%) as shown in figure no. 3.

The present study was carried out from January 2014 to July 2015 period. Averages of two years were collected from January to July month. It was observed that in month of September and November maximum number of sudden cardiac deaths was seen i.e.11 (8.03 %) each (figure no. 4). It was observed that the persons having habits of smoking and alcohol outnumbered the other risk factors. Male outnumbered the female in all risk factors. Out of 50 (36.50%) cases of sudden cardiac deaths in chronic smokers, 46 were male and 4 were females. Whereas, 24(17.52%) male cases were chronic alcoholic, had significant risk factor for sudden cardiac

deaths.One case of intravenous heroin abuser leads to infective endocarditis was also seen (table no.2).

There were 48 (35.04 %) cases in which time of onset of symptoms was between 06 hrs. to 12 hrs, followed by the 18 hrs. to 24 hrs. in 43 (31.39%) cases. The least number was seen in 00-06 hours i.e. 20 (14.60%) cases (figure no. 5).   Majority of cases were died between 1-6 hours of onset of symptoms i.e. 85 (62.04%), while 31 (22.63%) cases died within 1 hour of onset of symptoms as shown in figure no. 6.

According to distribution of cases in sudden natural cardiac death, ischemic heart disease contributed maximum number of deaths i.e. 126 cases (91.97%). Out of which, 81 (59.12%) cases showed critical coronary stenosis which belonged to 51-60 years age group, followed by healed myocardial infarct i.e. in 33 (24.09%) cases (table no. 3, 4).

Out of 137 cases of sudden natural cardiac deaths, significant coronary artery was blocked in 81 cases. Maximum number of coronary arteries were blocked within 2 cm of origin of the artery i.e. 60 (74.07%) and in 21 (25.93%) cases block was present beyond 2 cm of their origin (figure no.7).Single vessel was blocked in 48 cases, two vessels were blocked in 18 cases and triple vessel block was seen in 15 cases. Block was most commonly seen in left anterior descending artery (LAD) 38 cases (46.91%).

In another category distribution, valvular stenosis contributed 8 cases (5.84%), out of which 4 deaths were due to aortic stenosis which belonged to 41-50 years age group. While congenital anomalies contributed 3 cases (2.19%) as shown in table no. 5, 6 and 7.
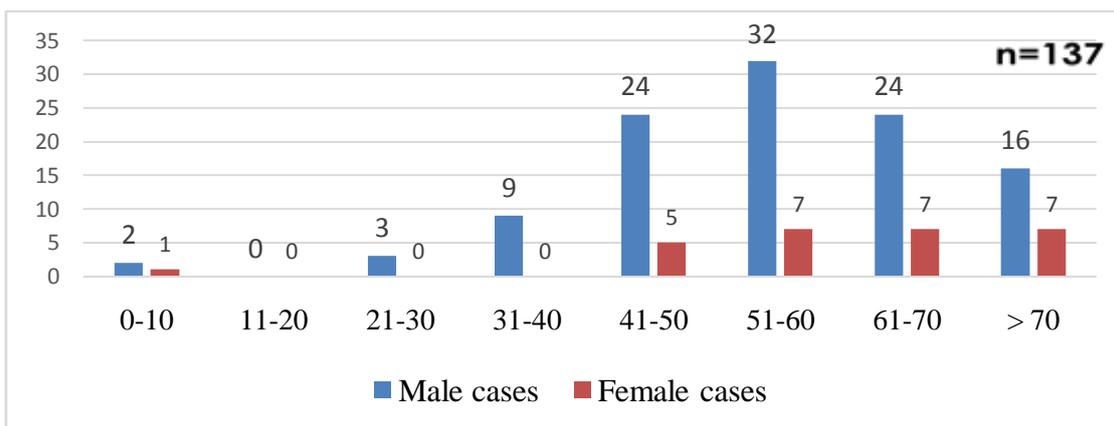

Fig. 1: Showing age and sex distribution

Table 1: Occupation wise distribution of sudden natural Cardiac deaths

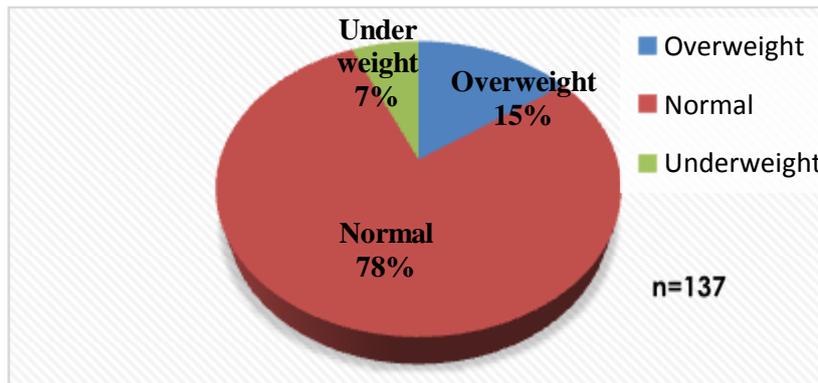| Occupation	Number of cases	Percentage
Not applicable (<18 years / student)	3	2.19
Employee: Public / Private sectors	4	2.92
Business	2	1.55
Laborer	6	4.38
Industry workers	**63**	**45.99**
Unemployed	4	2.92
Retired (>60 years)	44	32.17
Housewife	11	8.03
Total	137	100

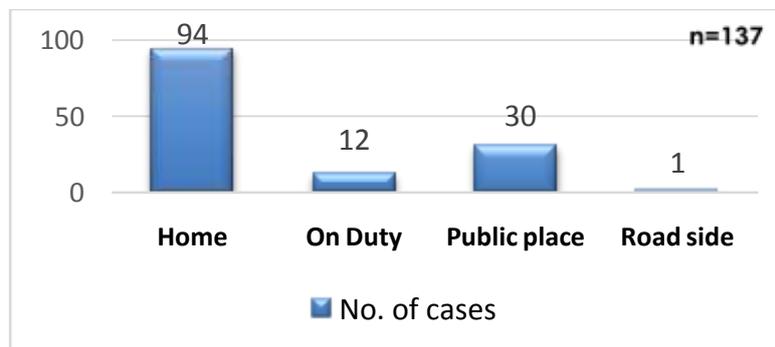**Fig. 2: Showing distribution of cases according to nourishment**

Fig. 3: Showing distribution of cases according to Place of incident
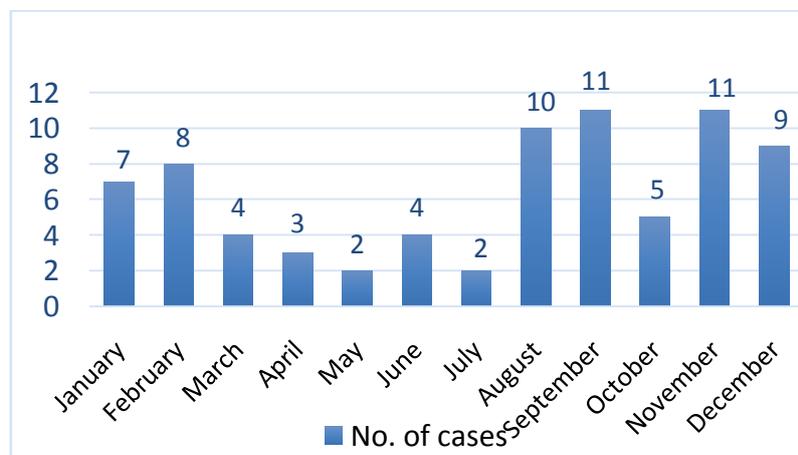

Fig. 4: Showing distribution of cases according to Month

Table 2: shows Distribution of cases according to Modifiable risk factors assessed for sudden cardiac deaths

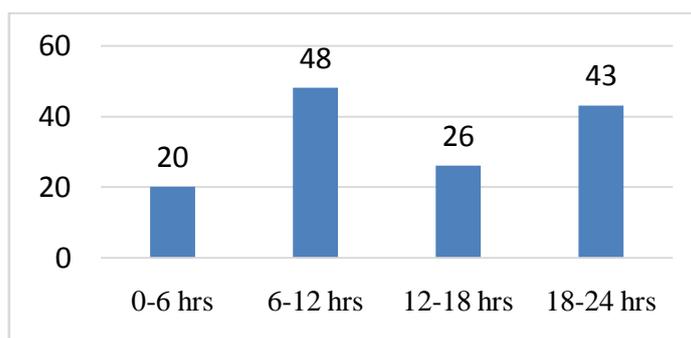| Risk Factors	CVS		Total
	M	F	M+F
HTN	13	05	18
DM	13	03	16
HTN + DM	09	05	14
Cigarette Smoking	**46**	**04**	**50**
Alcohol	24	--	24
Drug abuse	01	--	01
Not Known	04	10	14
Total	110	27	137

Fig. 5: Showing distribution of cases according to time of onset of symptoms
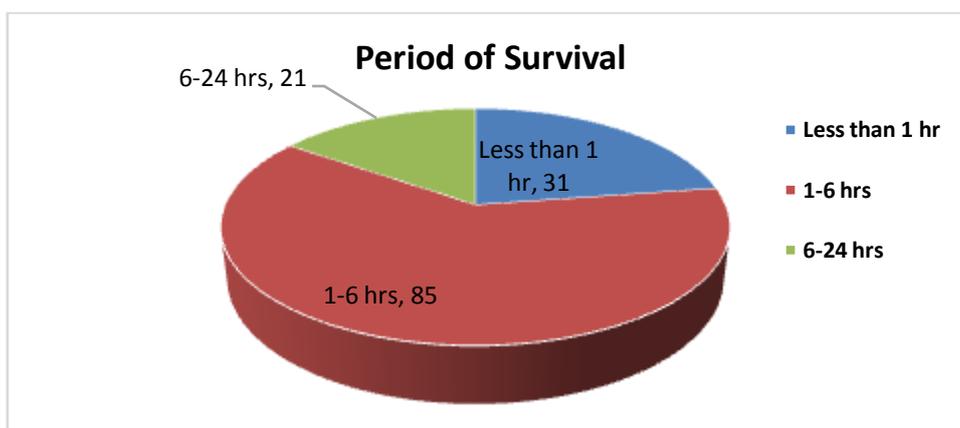

Fig. 6: Showing period of survival after onset of symptoms

Table 3: Showing diseases and sex-wise distribution of cases (Category I)

I	Diseases	Male	Female	Total
Ischemic Heart Disease	**a) Critical coronary Stenosis (No features of Myocardial Infarction)**	**66**	**15**	**81**
	b)Acute Myocardial Infarction	02	--	02
	c) Cardiac Rupture	04	--	04
	d)Healed Myocardial Infarct	24	09	33
	e)Left Ventricular Hypertrophy	06	--	06

Table 4: showing Disease-wise affection in different age group

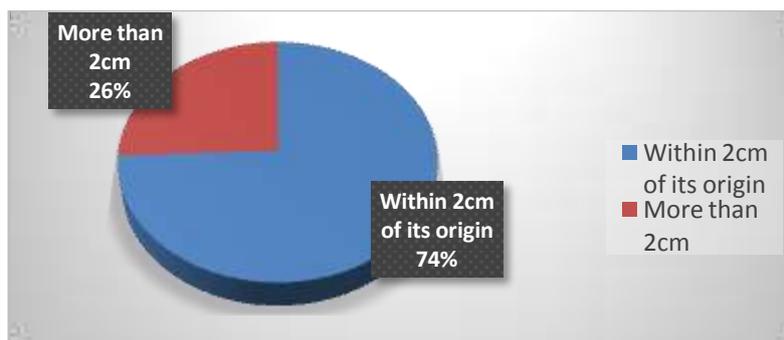| Age (Yrs.)	Critical coronary Stenosis M/F	Acute Myocardial Infarction M/F	Healed Myocardial Infarct M/F	Left Ventricular Hypertrophy M/F	Cardiac Rupture M/F	TOTAL M/F
21-30	01/--	--	--	01/--	--	02/--
31-40	07/--	01/---	--	--	--	08/--
41-50	16/03	01/--	03/02	02/--	--	22/05
51-60	**22/04**	**--**	**05/02**	**02/--**	**02/--**	**31/06**
61-70	13/04	--	09/02	--	02/--	24/06
> 70	07/04	--	07/03	01/--	--	15/07
Total	66/15	02/--	24/09	06/--	04/--	102/24

Fig. 7: Showing distribution of cases according to site of coronary artery block

Table 5: showing diseases and sex-wise distribution of cases (Category II)

II	Diseases	Male	Female	Total
Valvular Stenosis	**a)Aortic stenosis**	**03**	**01**	**04**
	b)Mitral stenosis	01	01	02
	c)Prosthetic Valvular Dysfunction	01	--	01
	d)Infective Endocarditis	01	--	01

Table 6: showing diseases and sex-wise distribution of cases (Category III)

III	Diseases	Male	Female	Total
Congenital Anomalies	a) ASD + VSD	01	01	02
	b) Pulmonary Stenosis	01	--	01

Table 7: showing Disease-wise affection in different age group

Age (Yrs.)	Valvular Stenosis				Congenital Anomalies		TOTAL M/F
	Mitral Stenosis M/F	Prosthetic Valvular Dysfunction M/F	Aortic Stenosis M/F	Infective Endocarditis M/F	ASD/VSD M/F	Pulmonary Stenosis M/F	
0-10	--	--	--	--	01/01	01/-	02/01
11-20	--	--	--	--	--	--	--
21-30	--	--	--	01/--	--	--	01/-
31-40	--	01/--	--	--	--	--	01/--
41-50	--	--	02/--	--	--	--	02/--
51-60	01/01	--	--	--	--	--	01/01
61-70	--	--	--/01	--	--	--	--/01
> 70	--	--	01/--	--	--	--	01/--
Total	01/01	01/--	03/01	01/--	01/01	01/--	08/03

DISCUSSION

The definition of sudden death varies according to authority and convention. The definition of sudden death used in the present study is "A death which is not known to have been caused by any trauma, poisoning or violent asphyxia, and where death occurs all of a sudden or within 24 hours of the onset of terminal symptoms" [14]. The duration of the death process has ranged from minutes to hours, but it is difficult to determine how long the fatal symptoms have been present, as death often occurs before the victim reaches hospital, in situations in which no data on the symptoms are available for want of eye witnesses. The incidence of sudden unexpected deaths varies greatly because of the aforementioned interpretative difficulties and differences in postmortem legislation from one country to another. This study deals only with material from postmortem and histopathological examinations, and the cases were selected during the study period.

In the present study, it has been observed that incidence of sudden natural deaths was 12.89 % i.e. in 282 cases out of 2187 total deaths amongst the medico legal autopsies conducted during the study period. Out of which, 137 cases (48.58 %) involved the cardiovascular system.

The study of Nandy [1] shows the incidence of sudden death was 10%. The study by Zanjad et al [30] and Rao et al [16] show the incidences of sudden unexpected death 8.92% and 8.67% respectively. Thus the incidences of sudden natural deaths in the present study are consistent with the study of Nandy [1], Zanjad et al [15] andRao et al [16].

In the present study, most of the male deaths, 32 (23.36%) cases belonged to 51 to 60 years age group. While maximum cases of female deaths i.e. 7 (5.11%) belonged to above 51 years age group. Derya A. A. [17] showed that the largest number of sudden natural death was in the age group of 50-59 years. As per Rao et al [16] maximum number of sudden deaths (n=74) were reported in between the age group 45-65 years (n=51). This may be due to westernization of Indian society, sedentary life style and increased smoking habit and alcohol drinking. In the present study it has been observed that, maximum cases of sudden death were seen in age group of 51 to 60 years in males, as this age group is more prone to pathological changes due to various eating habits, indiscriminate use of alcohol, smoking and tobacco, sedentary life style, stress and strain in life and lack of regular medical check-up.

Workers in industries, mills, shops, farm and other sectors constituted highest number of cases i.e. 63 cases (45.99 %), followed by retired person (>60 years) i.e. 44 cases (32.17%). It coincides with study of Kumar et al [18] where majority of the patients came from the semiskilled–unskilled group. The preponderance in workers is possibly due to low socioeconomic status, neglect of alarming symptoms of illness, non-affording treatment, physical and mental stress etc. In retired age group, there is increase in prevalence of many conditions with age, more stress and lack of regular medical check-up leads to sudden natural death.

Maximum deaths were observed in normally nourished 107 (78.10%) cases, followed by overweight 20 (14.60%) cases. The preponderance in normally nourished group is possibly due to, surrounding area being predominantly of low socio-economic population who works in industries and mills. This finding is not consistent with Yen Chen Linet al [19] which showed that obesity was a risk factor in 38 out of 70 cases of coronary artery disease.

It was observed that most of the sudden cardiac deaths occurred at home i.e. 94 cases (68.61%). In the study of Kuller et al [20] in 62.4% cases place of onset of symptoms was at home. Fornes et al [21] and Derya A. A. [17] showed that sudden coronary death occurs in 83% and67.7% of cases at home respectively.

September and November month showed maximum number of sudden cardiac deaths. According to Phillips D P et al [22] Sudden cardiac deaths tended to peak around Christmas and New Year in December month, suggesting a potential role for overindulgence, holiday stress, and increased delay to seek medical attention as well. In India, September and November months come under festive season, in which festivals like Diwali and Ganesh Chaturthi celebrated. During this period, diet and alcohol consumption often change. Many drink alcohol, often much more than during the rest of the year. Stress has received scrutiny as a possible cause, given the ability of stress-related catecholamine hormones to trigger sudden natural Death.

Regarding the correlation between diseases leading to sudden natural deaths and modifiable risk factors like chronic habits (alcoholism, smoking and drug abuse), significant medical history like hypertension, diabetes mellitus. In the present study it has been observed that out of 137 cases, 106 (77.37 %) male cases and 17 (12.41 %) female cases have significant risk factors.

Smoking is one of the significant risk factor in sudden natural death. Out of 50 cases of sudden cardiac deaths in smokers, 46 (92 %) were male and 4 (8 %) were females. Smoking increases the risk of Coronary Artery Disease. It is independent risk factor for MI. The risk increases with degree and duration of smoking.

Myeongki Hong et al [23], Yen Chen Lin et al [19] observed smoking to be most common risk factor in their studies with prevalence of 439/631 and 52/70 respectively. Hence, quitting smoking may reduce the risk.

Various studies had contradictory findings of alcohol intake and risk of sudden cardiac deaths. Though alcohol could not be established as independent risk factor in combination it may augment the effect of other risk factors. Benito M and Covadonga A [24] in their study found that 27% cases of Coronary Heart Disease had recent history of alcohol intake and/or drug abuse. In the present study, 24 (17.52%) male cases were chronic alcoholic, had significant risk factor for sudden cardiac deaths.

Chronic drug abuse is one of the major risk factors for sudden natural death. Infective endocarditis (IE) is one of the most severe complications in intravenous drug abusers. IE usually involves the tricuspid valve, but in present study, there was history of chronic intravenous heroin abuse which leads to infective endocarditis on both sides of heart.

The most common time of onset of symptoms was between 06 hrs.to 12 hrs.in48 (35.04 %) cases. This finding are consistent with VA Chaudhari et al [25] who explained the higher frequency in the morning hours because there is more stress of reaching office early, hectic daily schedule, transportation, fulfilment of duties, work load etc. The early morning heart rate and blood pressure surge increases the hemodynamic stress on any vulnerable atherosclerotic plaque, and can thus be regarded as a potential triggering factor for SCD and acute coronary syndromes. This adverse situation is further amplified by increased sympathetic activity and plasma catecholamine concentration. Several studies have found evidence for an increased coagulability during the morning [26]. For instance, Tofleret al [27] found increased platelet agreeability during the hours 6:00 to 9:00 in the morning.

In present study, ischemic heart disease contributed maximum number of deaths i.e. 126 cases (91.97%). Out of which, 81 (59.12%) cases showed critical coronary stenosis which belonged to 51-60 years age group, followed by healed myocardial infarct i.e. in 33 (24.09%) cases. The study of Nordrum et al [28] shows that 90.54% cases were due to coronary atherosclerosis and median age was 58 years. As per Sarkioja et al [29] study, the most common single cause was coronary artery disease which accounted for 80.85% of cardiovascular deaths and 49.35% of sudden death, 92.1% were male and 7.89% were female. Coronary artery disease was the most important cause not only among deaths due to cardiovascular causes but also among sudden deaths with most affected age group

51-60 years and this finding is consistent with the present study.

Maximum numbers of coronary arteries were blocked within 2 cm of origin of artery i.e. 60 (74.07%). It coincides with findings quoted in textbooks of Robbin and Dikshit [30]. Coronary arteries are not uniformly vulnerable to atheromatous lesion. Major trunks are most affected when they lieepicardially, more distal intramuscular branches are less prone. The most common site is first 2 cm of left anterior descending artery. Next most common site is right coronary artery distal part at the right margin of heart. Third most common place is proximal part of left circumflex artery soon after bifurcation from common trunk, which is next most frequent site [31].

A death due to single vessel block was most common i.e. in 48 cases and left anterior descending artery (LAD) was most commonly involved artery i.e. in 38 cases (46.91%). The LAD is considered the most important of the three main coronary arteries and is almost always the largest. The Left anterior descending artery typically supplies over half of the heart muscle with blood, so twice as much as the other coronary arteries. For this reason, a major blockage occurs at the beginning of the artery.

The incidence of Prosthetic valve thrombosis has been reported to average 0.2% per patient-year after aortic valve replacement [32]. Thrombosis of mechanical aortic valve prosthesis is a rare but life-threatening complication. In present study, there was history of valve replacement surgery about 15 years back. On examination, thrombotic material showed complete immobilization of both leaflets of mechanical aortic prosthesis valve leading to sudden cardiac death. Infective Endocarditis usually involves the tricuspid valve, but in present study, there was history of chronic intravenous heroin abuse which leading to infective endocarditis on both sides of heart. Grossly showed polypoidal pale yellowish to brown friable vegetation, microscopically friable vegetations of fibrin and platelets with inflammatory cells were seen.

CONCLUSION

The incidence of sudden natural deaths among the total medico legal autopsies is 12.89% and sudden natural cardiac deaths are 6.26%.

Most of the sudden natural cardiac deaths are in the age group of 51-60 years (39) closely followed by 61-70 years (31) cases. This may be due to westernization of Indian society, sedentary life style and increased indulgence to smoking and alcohol.

Out of 137 cases of sudden cardiac deaths, 110 cases (80.29%) are male and 27 (19.71%) are female.

The male to female ratio is 4.07:1.The reason behind that is because, male is more indulged in to the risk factors like smoking, alcohol consumption, bad eating habits and lack of regular medical checkup. On the other hand, in females, estrogen has vasoprotective effects

Industry workers constituted highest number of cases i.e. 63 (45.99 %). This is possibly due to low socioeconomic status, neglect of alarming symptoms of illness, non-affordable treatment, physical and mental stress.

Maximum deaths are observed in normally nourished 107 (78.10%) cases. The preponderance is possibly due to, surrounding area being predominantly of low socio-economic population who works in industries and mills.Most of the cases of sudden natural cardiac deaths, i.e. 94 cases (68.61%) take place when the deceased is in his/her home.

Most of the sudden natural cardiac deaths are in the month of September and November. September and November months come under festive season, during this period, diet and alcohol consumption often change and stress-related catecholamine hormones trigger sudden natural Death.

Persons having habits of smoking and alcohol outnumbered the other modifiable risk factors. Smoking increases the risk of Coronary Artery Disease and alcohol in high doses for long duration act as additional risk factor.

Most common time of onset of symptoms is between 06 hrs.to 12 hrs.in48 (35.04 %) cases. The reason behind that is more stress of reaching office early, hectic daily schedule, transportation, fulfillment of duties, work load and also increased sympathetic activity and plasma catecholamine concentration. Majority of the deaths are within 1-6 hours of onset of symptoms i.e. in 85 (62.04%) cases.

Among Ischemic heart disease, maximum deaths 81 (59.12%) are due to critical coronary stenosis which belonged to 51-60 years age group, followed by healed myocardial infarct i.e. in 33 (24.09%) cases.

Coronary arteries in 60 cases (74.07%) are frequently blocked within 2 cm of origin. Explanation to this finding may be due to, major trunks are most affected when they layepicardially, and more distal intramuscular branches are less prone. Single vessel is blocked in 48 cases and LAD in 38 cases (46.91%) is frequently involved. This is because, Left anterior descending artery typically supplies over half of the heart muscle, so twice as much as the other coronary arteries.

Valvular stenosis contributed 8 cases (5.84%), out of which 4 deaths are due to aortic stenosis which belongs to 41-50 years age group.

Cardiovascular pathology is a major contributor for sudden death. In most of the patients the first and only clinical expression of coronary atherosclerotic process is sudden death. The role of the Forensic pathologist is to provide a detailed examination of the organs, especially heart, in order to identify a definitive cause of death. Meticulous post-mortem and histopathological examination are need of hour to minimize risk of autopsy being negative or obscure one. Newer techniques are found to be helpful in diagnosis of cause of death especially in sudden unexpected deaths in persons without any signs of disease.

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