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Original Research Article

Postmortem Study of Sudden Death with Special Reference to Cardiovascular Causes

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Abstract

Introduction: The present study is carried out on cases died due to sudden natural causes which were brought for medico-legal autopsy to our institute. The study was aimed at analyzing the medico-legal and epidemiological aspects in cases of sudden natural deaths with special reference to cardiac causes. **Material & methods:** Total 2088 autopsies were conducted, out of which, 221 cases (10.58%) were of sudden natural death. Various factors like age, sex, time of incident, survival period, occupation, marital status, month wise distribution, seasonal variations, locality, religion, nourishment, habits, injuries, system wise affection, disease and sex wise distribution, cases of MI, distribution of coronary artery block, location of coronary artery block, cut section of ventricular wall, multisystem involvement to the body were studied. **Results:** Amongst these 221 cases, 195 cases (88.23%) were male and 26 (11.76%) were female. The male to female ratio was 7.5:1. It was observed that cardiovascular system was the most vulnerable to sudden death contributing to 114 (51.59%) deaths. **Conclusion:** Among cardiovascular causes, maximum deaths (96.49%) were due to coronary artery disease followed by mitral stenosis 2 cases, cardiac tamponade and Ventricular heart disease 1 case each. Most commonly affected age group was 41-50.

1. Introduction

Death is defined as complete and irreversible stoppage of the circulation, respiration and brain functions. The definition holds that life is sustained on three interlinked vital systems namely - the nervous, of entry.[1] Forensic pathologists deal not only with criminal, accidental and suicidal deaths, but also with circulatory and respiratory system – so called as "Tripod of life". It is obvious that all systems would fail if any one of the vital systems fails and that is why these systems are known as "atria mortis" i.e. the death's portals 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. It is quite possible for a person to be in apparently

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perfect health but at the same time suffering from a serious disease of which he may not be aware. Sudden deaths are important from a medico legal standpoint as they raise suspicion of foul play. The incidence of sudden death is 10% of all deaths. Among these, those due to pathology in cardiovascular system are predominant (45%), followed by those due to pathology in respiratory system (20%). About 15% are due to central nervous system pathology, 6% due to alimentary causes, about 4% due to genitourinary causes and the rest (10%) are due to miscellaneous causes.[2] A sudden cardiac death occurs when the heart stops beating or is not beating sufficiently to maintain perfusion and life. Despite advances in the screening and the diagnosis of cardiovascular disease, sudden cardiac death is often the first manifestation of an underlying heart problem in apparently healthy individuals. The incidence of sudden natural deaths are not uniform and it depends on many factors such as sex, age, ethnic group, chronological criteria and methodology of diagnosis.[3] The present study had been conducted in the Department of Forensic Medicine and Toxicology with aim to determine the exact cause of sudden natural death with special reference to cardiac causes. The objectives were:

1. To study the incidence of heart related sudden death in various age groups and their sex
2. To study the incidence of heart related sudden death in different gender.
3. To study the incidence of heart related sudden death and its relation to location of coronary artery block.
4. To study the relation of cut section of ventricular wall and CVS causes

2. Materials and methods:

All cases, irrespective of age groups and sex, who died suddenly and/or unexpectedly and brought to our institute for post-mortem examination, were studied.

Criteria for selection of cases were as follows.

Inclusion criteria:

1. The cases, which were admitted in our or other private hospitals, died within 24 hours of onset of terminal symptoms of natural disease and then brought to our hospital, for post-mortem examination, were included in this study.
2. The cases which were brought in casualty of our hospital, or the cases where the death was unobserved/unattended, 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.

Exclusion criteria:

1. The cases, where the unnatural means such as trauma, violent, asphyxia or poisoning had caused the death were not included in this study.
2. The cases where cause of death turned out to be unnatural were not included in this study.
3. The cases where cause of death remained obscure even after detailed post-mortem examination were not included.

In case of hospitalized patients, medical reports were studied and the provisional causes of death written in it were noted. Before starting the post-mortem examination, history about the onset of symptoms, their duration and habits was obtained from the relatives whenever available. In cases, where the death was unobserved / unattended and the dead body was brought directly from site of death to our institute by police for post-mortem examination and/or where the relatives were not available, help of police inquest was taken regarding the manner and cause of death.

AUTOPSY TECHNIQUES: Routine autopsy techniques were followed. Cavities opened and organs were examined in-situ before removal. The organs were then dissected out by routine dissection technique. Weight of all organs was taken before dissection. Gross examination of the organs was performed and each individual organ was dissected as per the standard autopsy technique. Heart is opened in the direction of the flow of blood. The enterotome is introduced first through inferior vena cava and extends into the opening of the superior vena cava and right atrium is cut between the openings of these two veins. In opening the right ventricle, the enterotome is introduced into the atrium, cuts through the tricuspid orifice and opens the right ventricle along the right lateral wall (Margo acutus). In opening the pulmonary valve, the enterotome is introduced into the right ventricle close to apex and conus pulmonalis and the valve are cut along the interventricular septum.The left atrium is opened by cutting the line connecting the opening of the pulmonary veins. The left atrium is incised along its

left lateral wall, the incision extends through the mitral orifice and continuing along left lateral wall of heart (Margo obtusus), opens left ventricle. Next the line of incision extends from apex along the interventricular septum into the aorta, opening the aortic valve. The coronary arteries are examined for their consistency & then by making serial parallel cross sections along the entire course of the major vessels about 2 mm apart, using a scalpel. This method demonstrates narrowing of the vessel, and any ante mortem thrombus in its lumen.[4]

3. Results:

The present study was carried out in the Department of Forensic Medicine and Toxicology from 1st January 2009 to 31st December 2009. During this period, 2088 autopsies were conducted, out of which, 221 cases (10.58%) were of sudden natural death. Amongst these 221 cases, 195 cases (88.23%) were male and 26 (11.76%) were female. The male to female ratio was 7.5:1. It was observed that cardiovascular system was the most vulnerable to sudden death contributing to 114 (51.59%) deaths. **Table no. 1 to 5** shows detailed results of the present study.

Table no. 1: Showing Cardiovascular diseases and sex-wise distribution of cases

System & diseases	Male deaths	Female deaths	Total deaths
CAD	72	05	77
CAD + AMI	29	--	29
AMI	04	--	04
Mitral stenosis (MS)	01	01	02
VSD	--	01	01
CT	01	--	01

CAD: Coronary artery disease, AMI: Acute Myocardial Infarction. **VSD:** Ventricular septal defect, **CT:** Cardiac Tamponade.

Table No. 2: Showing cases of myocardial infarction (MI)

Myocardial Infarction (MI)	No. of Cases	M/F	Percentage
Old	37	36/01	86.05
Recent	06	06/--	13.95
Total	43	42/01	100

Table No. 3: Distribution of block in coronary artery disease.

Site of block	Within 2 cm of its origin	More than 2 cm	Total
Number of cases	110	18	128
Percentage	85.94	14.06	100

Table No. 4: CVS – Disease-wise affection in different age group

Age (Yrs.)	CAD M/F	CAD + AMI	AMI M/F	MS M/F	CT M/F	VSD M/F	TOTAL M/F
0-10	--	--	--	--	--	--/01	--/01
11-20	--	--	--	--/01	--	--	--/01
21-30	04/--	03/--	--	--	--	--	07/--
31-40	22/--	04/--	01/-	01/--	--	--	28/--
41-50	**23/01**	**09/--**	**--**	**--**	**01/-**	**--**	**33/01**
51-60	14/02	07/--	01/-	--	--	--	22/02
61-70	08/02	04/--	02/-	--	--	--	14/02
> 70	01/--	02/--	--	--	--	--	03/--
Total	72/05	29/--	04/-	01/01	01/-	--/01	107/07

Table no. 5: Location of coronary artery block

Single vessel				Double vessel		Triple vessel	Total
LAD	LCM	RC	LC	LAD+ LCM	LAD+ RC	LAD+LC+R C	
63	2	7	2	23	11	19	127

4. Discussion:

The definition of a 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 the terminal symptoms”.[5]

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 situation 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 examinations, and the cases were selected during the study period, with lack of proper registration of deaths, therefore statistical incidence of sudden death is not attempted.

In the present study, it has been observed that incidence of sudden natural death was 221 cases out of 2088 total deaths (10.58%) amongst the

medico legal autopsies conducted during the study period.

It was observed that maximum deaths were related to cardiovascular system 114 (51.59%) cases, followed by Respiratory system 55 (24.89%) cases. In this study maximum deaths were due to coronary artery disease 110 cases (96.49% of CVS deaths), followed by pulmonary tuberculosis 37 cases. Preponderance to cardiovascular diseases is due to various risk factors, physical and mental stress and food habits, addictions and lack of exercise which affect the mostly cardiovascular system.

Luke et al studied 275 cases of sudden unexpected death from natural causes. There were 105 deaths (38%) related to circulatory system.[6] The study of Penttila A shows that cardiovascular diseases comprised the major proportion of all sudden natural deaths, whereas respiratory cause were the leading category in the remaining cases.[7] Durigonet al out of 77 cases of sudden death, 72.7% of cases died from cardiovascular disease.[8] Nandy A stated that, most of the deaths were due to cardiovascular causes accounting about 45% among all the cases of sudden deaths.[2] Reddy Narayan KS states that major causes are cardiovascular system (45-50%) followed by respiratory (15 to 23%).[9] The study of Zanjadet al shows that cardiovascular causes 111 (49.55%) cases were the leading causes of death followed by respiratory system 61 (27.23%) cases.[10] The study of Derya shows that the most common cause of sudden natural death was related to the cardiovascular system i.e. 153 cases (55%) and second most common cause was related to the respiratory system (19.1%).[11] In the study by Rao et al, about 66.67% of cases were due to cardiovascular pathology, 27.45% were due to pulmonary pathology.[12]

The present study coincides with studies of Luke et al, Penttila Anti, Durigon et al, Nandy A, Reddy Narayan K.S., Zanjad et al, Derya AA and Rao et al.[2,6-12]

Cardiovascular causes are the principle cause among sudden death in the present study. Out of 221 cases of sudden natural death, 114 cases (51.59%) were due to cardiovascular causes, of which 107 (93.86%) were male and 7 (6.14%) were female.

The study of Sarkioja et al shows that out of 77 cases of sudden deaths, 47 cases (61%) were due to cardiovascular causes, of which 43 (91.48%) were male and 4 (8.51%) were female.[13] Nordrumet al studied 428 cases of explained natural death by autopsy findings, which shows 296 cases (69.15%) died of cardiovascular diseases.[14] Out of 296 cases, 256 (96.48%) were male and 42 cases (14.18%) were female. The study of Thomas et al shows that out of 322 cases of sudden death, 224 (69.5%) cases were due to cardiovascular causes, of which 179 (79.91%) were male and 45 (20.08%) were female.[15] Zanjadet al cardiovascular cause 111 (49.55%) cases were the leading cause of death in which male: female ratio 1:0.178.[10] Derya in his study 153 (55%) of cases of sudden death was related to cardiovascular system in which 133 (86.93%) were male and 20 (13.07%) were female.[11] Rao et al in his study 66.67% of cases were due to cardiovascular pathology. In cardiovascular deaths male to female ratio was 7.5:1.[12]

Thus from all above studies, it is seen that cardiovascular cause was the principle cause of death among sudden death and more common in males than females which is consistent with the present study.

Cardiovascular System (CVS) Diseases – Disease-wise affection in different age group

In present study, it has been observed that out of 114 cases died of cardiovascular causes, 110 (96.49%) were due to coronary artery disease. Thus coronary artery disease was not only principle cause among cardiovascular causes but also important cause among sudden natural death amounting to 49.77%. Out of 114 cases, 107 (93.86%) were male and 7 (6.14%) were female.

The study of Sarkiojaet al shows that the most common single cause was coronary artery disease which accounted for 38 cases (80.85%) of 47 cases of cardiovascular deaths and 49.35% of 77 cases of sudden death.[13] Out of 38 cases of coronary artery disease, 35 cases (92.1%) were male and 3 cases (7.89%) were female. The study of Nordrumet al shows that out of 296 cases died of cardiovascular causes, 268 cases (90.54%) were due to coronary atherosclerosis.[14] Out of 428 cases of explained natural death, coronary atherosclerosis accounted for 62.61%. The study of Thomas et al shows that out of 224 cases died of cardiovascular causes, 189 cases (84.37%) were due to ischemic heart disease. Out of 322 sudden natural deaths, ischemic heart disease accounted for 58.7%.[15]

The study of Forneset al of sudden death out of hospital coronary deaths with no previous cardiac history, shows that 230 cases (73.5%) of sudden cardiac deaths are coronary in origin. The study of

Luke et al[6] shows that out of 105 cases of circulatory system, maximum deaths were due to coronary artery disease (28%).[16] The study of Di Maio et al shows that out of 609 deaths due to cardiovascular disease, 451 (74%) were attributed to coronary artery disease.[17] The study of DurigonM shows that 72.7% cases died from cardiovascular cause mainly coronary atherosclerosis.[8] The study of Zanjadet al Death due to coronary artery disease amounts to almost half of all sudden deaths (42.85%).[10] Derya shows that out of 278 cases of sudden death, 55% of cases related to cardiovascular causes, principally ischemic heart disease.[11]

Thus from all above studies, it is seen that coronary artery disease was the most important cause not only among deaths due to cardiovascular causes but also among sudden deaths and this finding is consistent with the present study.

In the present study, non-ischemic heart disease cases were 4 (3.51%) of all cardiovascular deaths, which include two cases of mitral stenosis, one case each of ventricular septal defect and cardiac tamponade.

In this material, deaths caused by complication to coronary atherosclerosis comprised the majority of the cases with an explained cause of death. Half of the coronary deaths had no morphological signs of recent events in the vessels or in the myocardium. Stenosis in the coronary arteries of more than 75% has been stated to have significant hemodynamic effects. Subjective assessment of the degree of coronary artery stenosis is probably difficult. If the stenosis was evaluated as significant and there was no other obvious cause of death, then the case was classified as a coronary death.

Cases of myocardial infarction (MI)

In the present study, it has been observed that recent myocardial infarction was seen in 6 (5.26%) cases of coronary artery disease (114) of which all male. Recent myocardial infarction was confirmed by histopathological examination. In 37 cases (32.46%) old myocardial infarction were seen on gross examination, of which 36 were male and 1 case of female.

Di Maio et al shows that out of 451 coronary artery disease cases, 157 (34.8%) showed gross scarring of the myocardium, with 38 cases (8.4%) giving evidence of an acute myocardial infarction grossly.[17] This finding does not match with the present study as histopathological examination was not conducted in all cases in Di Maio et al.

Farbet al 90 hearts were examined. Acute myocardial infarction present in 19 (21%) and healed myocardial infarction only in 37 (41%) and no myocardial infarction in 34 (38%).[18] This finding was not consistent with the present study.

Distribution of block in coronary artery disease

Maximum numbers of coronary arteries were blocked within 2 cm of origin of artery. It coincides with findings quoted in textbooks of Robbin and Dikshit.[19]

Location of coronary artery block

A death due to single vessel (58.27%) was common and left anterior descending artery (49.60%) was most commonly involved artery.

In the study of Luke et al shows twenty cases demonstrated recent complete coronary artery occlusion, 15 of the left anterior descending coronary.[6] In the study of Sarkiojaet al severe stenosis was located in the left descending artery in 58%, and in 52 % the disease was only in one vessel.13 In the study of Burke et al shows that 72% of hypertensive's with one vessel disease versus 17% of normotensives with one vessel disease.[20]

This coincides with studies of Luke et al, Sarkioja et al and Burke et al.[6,13,20]

Relation of cut section of ventricular wall and CVS causes of death

In present study it was observed that out of 114 cases solitary left ventricular hypertrophy in 67 cases (58.78%), biventricular hypertrophy present in 20 cases (17.54%), and solitary RVH in 3 cases (2.63%)cases.

The present study is consistent with the study done by Burke et al where in 71 hearts with CAD, LVH was present in 64% of hypertensive's versus 33% of normotensives.[20]

5. Conclusion:

The following conclusions are derived from the present study about the sudden death with special reference to cardiovascular system involvement.

- Among cardiovascular causes, maximum deaths (96.49%) were due to coronary artery disease followed by mitral stenosis 2 cases, cardiac tamponade and Ventricular heart disease 1 case each.
- Male to female ratio in cardiovascular disease was 15.29:1.

- Maximum CVS related deaths were observed in 41-50 years.
- Death due to coronary artery disease was maximum in age group 41-50 years.
- Out of cases 43 cases, 6 cases show changes suggestive of recent MI. In 37 cases, old healed scar of MI seen.
- Coronary arteries (89.55%) were frequently blocked within 2 cm of origin.
- Single vessel was blocked in 58.27% and LAD (49.60%) was frequently involved.
- Out of 114 cases, Solitary LVH observed in 58.78% cases followed by Biventricular hypertrophy 17.54% and solitary RVH in 2.63% cases.

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Contributor ship of Author: All authors equally contributed.

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