Original Research Article

Histopathological spectrum of cardiovascular findings in forensic autopsies in Hadoti region: A prospective study of one year

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ABSTRACT

Introduction: Heart diseases are now the biggest killer in the world. Many cardiovascular pathologies are concealed and found incidentally on post mortem examination.

Aim and Objectives: To analyse spectrum of histopathological lesions (related or unrelated to cause of death) in heart autopsies in Hadoti region of Rajasthan.

Materials and Methods: This was a one year prospective hospital-based study. A total of 133 whole heart specimen underwent detailed gross and microscopic examination.

Results: Most common histopathological finding was atherosclerosis, seen in 63 cases out of 133 autopsied hearts (47.3%), followed by myocardial hypertrophy in 31 cases and myocardial infarction in 20 cases. Age related changes were seen in 10 cases, severe congestion in 10 cases, myocardial fibrosis in 7 cases. 1 case each of infective endocarditis, myocardial calcification, ventricular rupture, myocarditis, LAD stent, fat embolism was noted. 51 hearts did not reveal any sort of pathology. Correlation of age with atherosclerosis showed a significant p value (0.0009). Males showed a slightly higher prevalence of atherosclerosis but it was not statistically significant. We had 39 (29.3%) cases of sudden cardiac deaths (SCD). SCD cases showed similar histopathological spectrum as all other causes of deaths, but percentage of each heart pathology was much higher in SCD. Most common finding among SCD cases was coronary artery disease (23 cases), followed by myocardial hypertrophy (22 cases) and myocardial infarction (13 cases). Myocardial Fibrosis was seen in 3 cases, age related changes in 2 cases, ventricular rupture in 1 case and severe congestion in 1 case. 61.5% SCD cases showed combination of two or more pathologies. Five SCD cases did not reveal any pathology.

Conclusion: In our study heart pathologies make a major contribution towards ill health and death in our society, atherosclerosis being the most common finding.

1. Introduction

Heart diseases are now the biggest killer in the world, in place of communicable diseases. As per a projection, over 23 million individuals worldwide will die from heart diseases in 2030.[1] In India, epidemiological studies show that cardiovascular risk factors are wide spread and heart diseases are already an important cause of mortality and morbidity.

The word "Autopsy" is derived from Greek word autopsia,[2] which means "to see (opsis) for oneself (autos)." There are a vast variety of cardiovascular pathologies and many are found incidentally on post mortem examination. Identifying this wide spectrum of lesions on histopathological examination of heart autopsies can help in studying the epidemiology, pathogenesis and management of these diseases. Against this background, the present study

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focuses on understanding the histopathological spectrum of cardiovascular system. Also, the severity and distribution of some of these lesions was observed in the bodies subjected to autopsy in our Institute which has good representation of all social classes.

2. Materials and Methods

A one year prospective study was conducted at Department of Pathology, Government Medical College, Kota, Rajasthan, from December 2020 to November 2021, for a period of 12 months, after prior ethical clearance. All autopsy heart specimens sent at pathology department to find cause of death or as a part of investigation of an unexpected/ suspicious death in a person with known or unknown cardiac disease were taken up for the study.

Our study included heart specimens of only natives of Hadoti region received within the study period. Heart specimens that were received autolyzed or belonging to deceased having different ethnicity (migratory population) were excluded.

2.1. History

History related to the circumstances of the death with special reference to any signs and symptoms suggestive of disease/disorder of cardiovascular system like chest pain, sweating, collapse was procured wherever possible. Personal details included age at death, gender, residence, date of death and date of receipt of specimen. All these details were procured from the details given by the Police / Magistrate in their post mortem requisition and case history.

2.2. Histopathological examination of heart specimen

The heart was weighed, after all blood/clot was removed and compared to standard cardiac weight tables and then investigated for the presence of scars/ pericardial lesions. Then heart was sectioned along the flow of blood and the cut surfaces of the muscles were examined for any signs of ischemia like loss of luster, mottling with yellow tan softening or scarring. Photographs were taken where ever needed. Measurements of right and left ventricular free wall thickness were noted at mid-ventricular level, 1 cm below the valves. Ventricular and atrial cavities were examined for clots/mass. Any valvular lesions were looked for. The aorta was opened longitudinally and analyzed for atheromatous plaque, calcification, aneurysm etc. The right and left coronary arteries were tracked, starting right from the ostia and then examined by making a series of cross incisions down the course of vasculature about 2-3 mm apart by a scalpel to demonstrate any narrowing due to plaque or ante-mortem thrombus (Figure 1). Coronary artery tissues were blocked and sectioned, according to need. High-grade stenosis was evaluated following decalcification. Bits were taken for microscopic examination from right and

left ventricles routinely (and both atria and inter-ventricular septum in case of suspected lesions), LCA, RCA, and Aorta.

Tissue bits were then processed through a series of formalin fixation, dehydration, clearing and wax impregnation steps and embedded in wax blocks. Tissue sections of 5 microns thickness were cut from each block, fixed to slides, deparaffinised and stained with haematoxylin and eosin stain. Then, dehydration, clearing and mounting with DPX (Distyrene Plasticizer Xylene) was done. All the sections were examined under 40x, 100x and 400x view of light microscope. The different histological findings were observed qualitatively and quantitatively and recorded. The microscopic findings were correlated clinically where ever possible. Special stains like Masson Trichrome, Von Gieson, Von Kossa were used to confirm histopathological findings where needed (Figures 2 and 3).

2.3. Statistical Analysis

Statistical analysis of results was done by Statistical Package for the Social Sciences (SPSS) version 20 (IBM Corp. SPSS statistics, in Armonk NY) for windows. Data were expressed as mean± standard deviation and range for quantitative variables, numbers, and percentage. The Chi square test was used to assess difference in categoric variables between groups. A p value of < 0.05 was taken as being of significance for all statistical tests.

3. Results

We received 140 autopsy heart specimens in the Department of Pathology during the study year. 5 heart specimens were received autolysed and 2 autopsies received for histopathological examination did not include heart. So, a total of 133 autopsy heart specimen underwent histopathological examination and were included in our study.

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3.1. Demographic profile

Out of 133 cases, males were 75.94% (101 cases) and females were 24.06% (32 cases). Male to female ratio was 3.1:1. The age range was 10-91 years and the mean age was 41.11 years (SD 15). Most common (35 cases, 26.31%) age group was 41-50 years and second most common age group was 31-40 years (28 cases, 21.10%) (Figure 4). Our study included cases from both urban (51.88%) as well as rural (48.12%) areas.

3.2. Heart Weight distribution

The heart weight (post fixation) ranged from 100 gm to 700 gm.

3.3. Cause of death

Clinical details showed that 29.3% cases had symptoms related to cardiovascular system like chest pain/tightness/discomfort, breathlessness, dizziness just prior to death or died suddenly, without any complaints. Second most common cause was poisoning (21.0%). 10.5% cases had history of snake bite (Figure 5).

3.4. Histopathological spectrum in heart autopsies

A wide spectrum of histopathological changes was seen (Table 1). The most common finding was atherosclerosis, seen in 63 cases. Secondly, myocardial hypertrophy was observed in 31 cases. Thirdly, myocardial infarction was seen in 20 cases, out of which 3 were acute M.I., 13 were healing M.I. and 4 were cases of healed M.I.

10 hearts showed age related changes - abundant lipofuscin in 6 cases and marked fatty infiltration in 4 cases which showed > 50% diffuse fat infiltrates of myocardial wall without thinning or dilatation, unlike normal hearts. No fibrous tissue was present.[3]

Severe congestion in myocardium was seen in 10 cases, out of these 6 were cases of Organo-phosphorous poisoning.

Myocardial fibrosis was seen in 7 cases including cases of both interstitial (reactive) and diffuse (replacement) fibrosis. One case each of Infective endocarditis, Myocardial calcification, Ventricular rupture, Fat embolism, Myocarditis and LAD stent was noted. No significant pathological changes were seen in 51 hearts.

3.5. Atherosclerosis

The present study population showed atherosclerosis in their coronary arteries and/or great vessels in a total of 63 cases (47.36%) in age group 10 – 91 years. Atherosclerosis was seen in coronary arteries in 56 cases, in great vessels in 23 cases and in both in 16 cases.

Out of 56 cases of atherosclerotic coronary artery disease (CAD), 80.3% had some degree of stenosis. 11cases out of these stenotic CAD had critical narrowing (>90% lumen block). Out of these, youngest case was a 38 year old male and oldest was a 80 year old female.

In 56 CAD cases, involvement of left coronary artery was more common (46 cases) than right coronary artery (42 cases).

Overall in the age group 10- 91 years, maximum cases of atherosclerosis were seen in age group 41-50 years (28.57%). With increasing age, the incidence of atherosclerosis increased from 23% in 2nd decade to 100% in 7th decade. 50.49% percent of the males and 37.5% percent of the females showed atherosclerosis.

Most common type of atherosclerosis was type 5 (16 cases) followed by type 4 (10 cases) (Table 2).

3.6. Sudden cardiac deaths

We had total 39 cases (29.3%) of sudden cardiac deaths (Table 3). Our study showed that as far as Hadoti region is concerned, the risk of sudden cardiac death (SCD) is highest in the age group 41-50 years and then in the age group 51-60 years. In our study, major bulk (94.8%) of all sudden cardiac death cases was seen up to 5th decade, while only 5.1% occurred after 5th decade. Atherosclerosis was the most common finding in SCD cases [58.9%, 23 cases]. A total of 11 cases showed critical stenosis in our study, out of which 90.9% had died of sudden cardiac death. 56.4% cases showed myocardial hypertrophy and 33.3% cases had myocardial infarction. More than half of SCD cases showed combination of various pathologies in the same heart like atherosclerosis, hypertrophy, ischemia, fibrosis etc. Three cases had four pathologies in same heart. Five cases of SCD did not reveal any sort of pathology even after detailed histopathological examination.

4. Discussion

Histopathological examination of heart in forensic autopsies can help in determining if death was due to or was contributed in any way by a cardiovascular pathology. Heart autopsies also help to establish the nature of cardiac disease and whether the mechanism of death was structural or arrhythmic. It helps in determining whether or not unnatural causes like trauma were responsible for death.

63.1% study population had some sort of heart pathology. Association of age with heart pathologies, when compared with normal hearts, was statistically significant showing a p value of 0.04.

Our study population was predominantly male (75.94%) with females constituting 24.06%. This may be due to a higher cardiac risk profile in men. Also, female autopsy rates are quiet low in our region.[4] Male predominance has been reported in most other autopsy studies also. (Garg et al.,[5] Gaikwad et al,[6] Sonawane et al[7] and Wang et al.[8])

Most of the cases were in the age groups 41-50 years and 31-40 years. A study conducted by Marwah et al[9] and Sonawane et al[7] also reported most cases between age group 41-50 years. While Garg et al[5] and Gaikwad et al[6] reported 51- 60 years as the most common age group. These differences in the age incidence may be due to variation in sample size.

Atherosclerosis was the most common histopathological finding. Though all studies have reported atherosclerosis to be the most common histopathological finding in autopsies of heart, the percentage of atherosclerosis has widely ranged in various studies from 61.5% (Dhankar, Khare et al)[10] to 27.2% (Patel et al).[11] These variations in the incidence of atherosclerosis in different studies can be due to difference in the populations studied based on life style, culture, race, diet, socioeconomic status and age range. Correlation
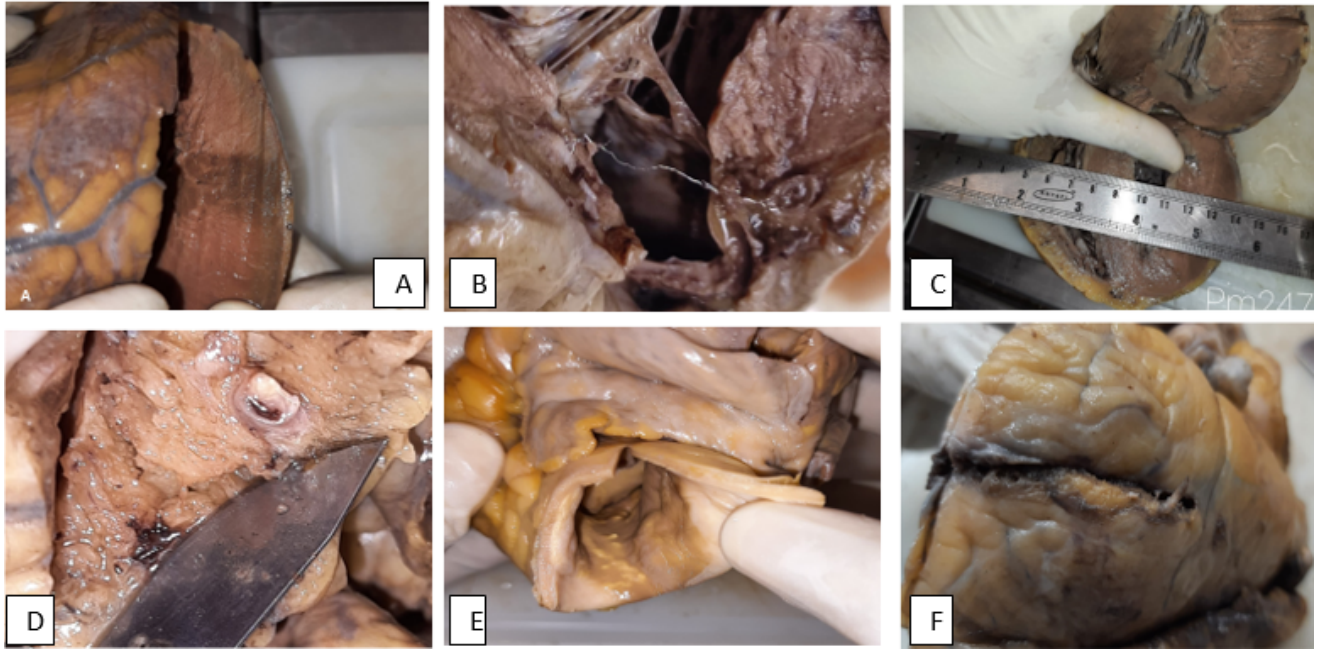
Fig. 1: Gross findings of heart revealing (**A**): Ventricular wall infarct (**B**): LAD stent (**C**): Left ventricular hypertrophy (**D**): Coronary artery disease (**E**): Atherosclerosis of great vessels (**F**): Ventricular rupture.
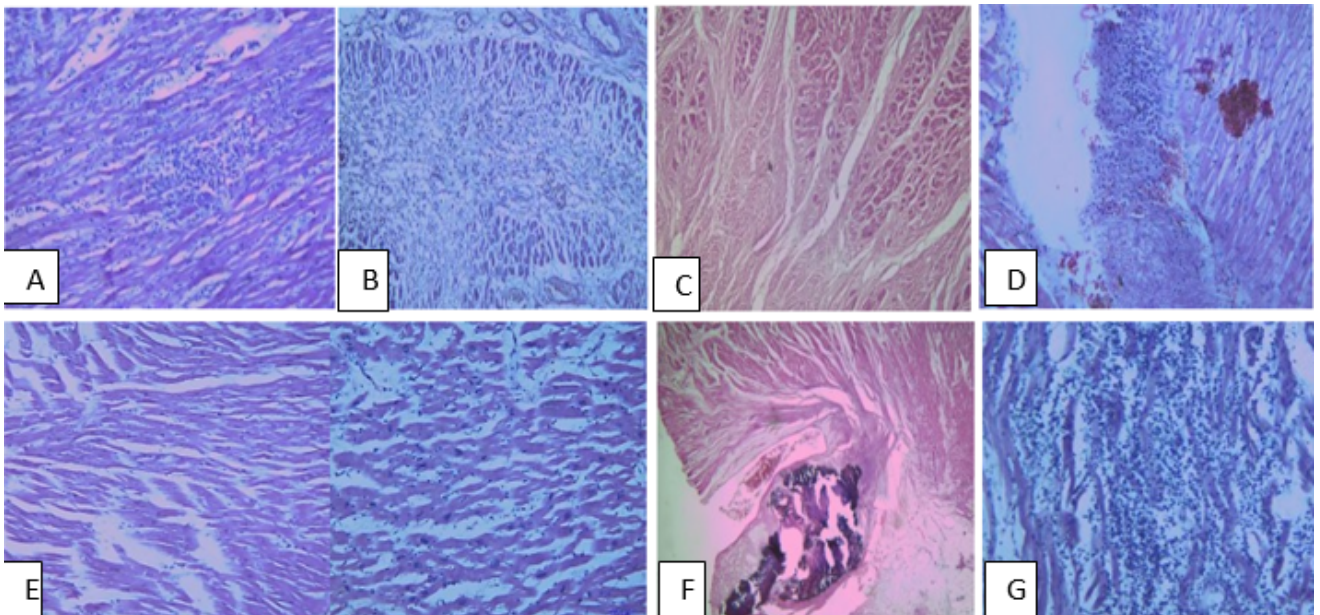
Fig. 2: Microscopic changes in heart (H&E) showing (**A**): Acute myocardial Infarction (MI) with abundant neutrophilic infiltrate and myonecrosis 20x (**B**): Healing MI 20x (**C**): Healed MI with variable fibrosis 10x (**D**): Infective endocarditis 20x (**E**): Myocardial hypertrophy in comparison to normal myocardium 20x (**F**): Myocardial calcification 4x (**G**): Myocarditis 20x.
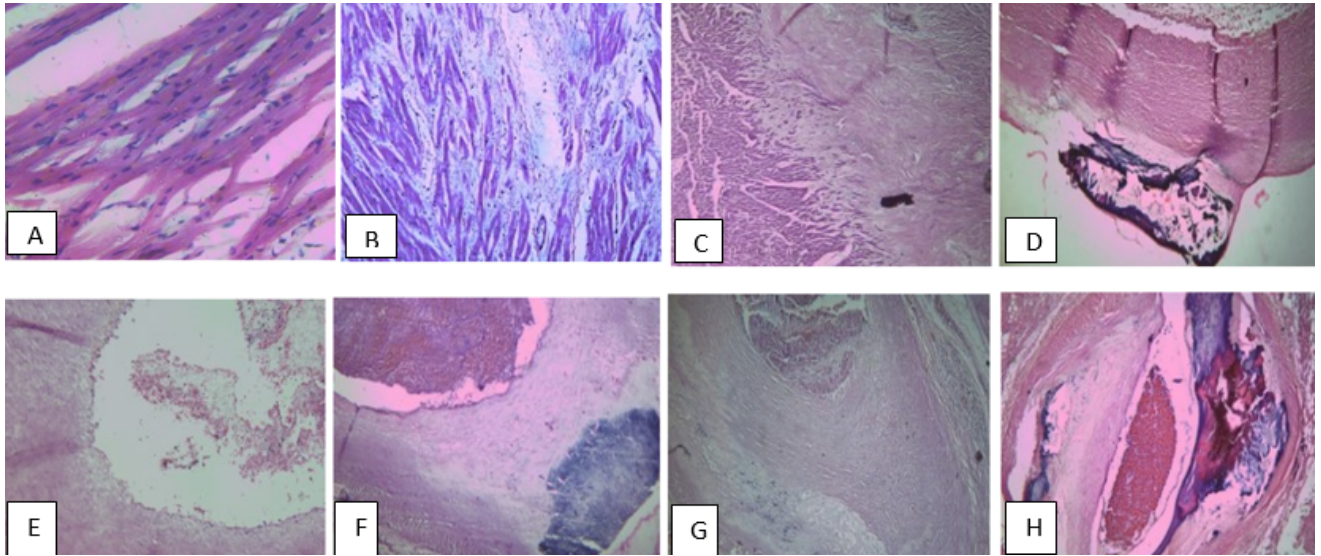
Fig. 3: Microscopic changes in heart (H&E) showing (**A**): Age related changes– abundant lipofuscin 40x (**B**): Interstitial myocardial fibrosis 20x (**C**): Diffuse myocardial fibrosis10x (**D**): Atherosclerosis of great vessel 4x; (**E**), (**F**), (**G**), (**H**): CAD – Atherosclerosis type 2 (10x), type 5 (4x), type 6 (4x), type 7 (4x)
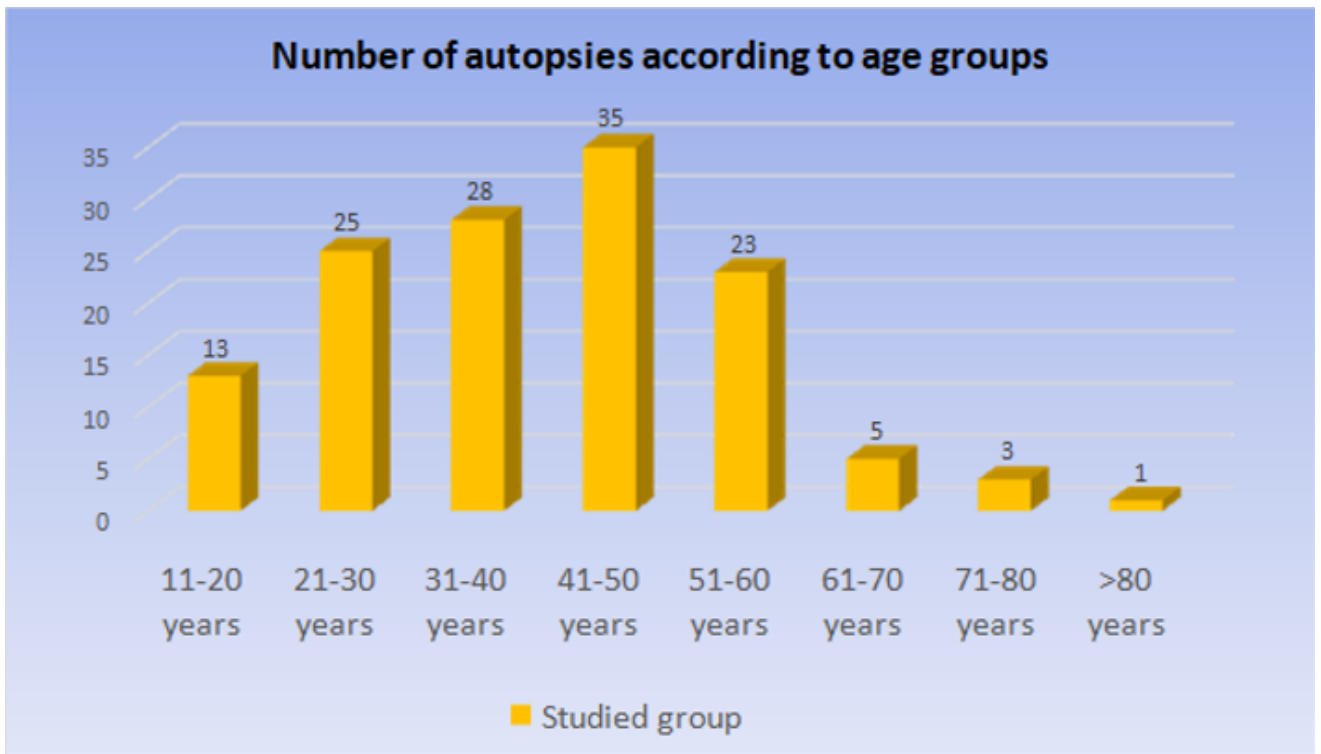
Fig. 4: Number of autopsies according to age group
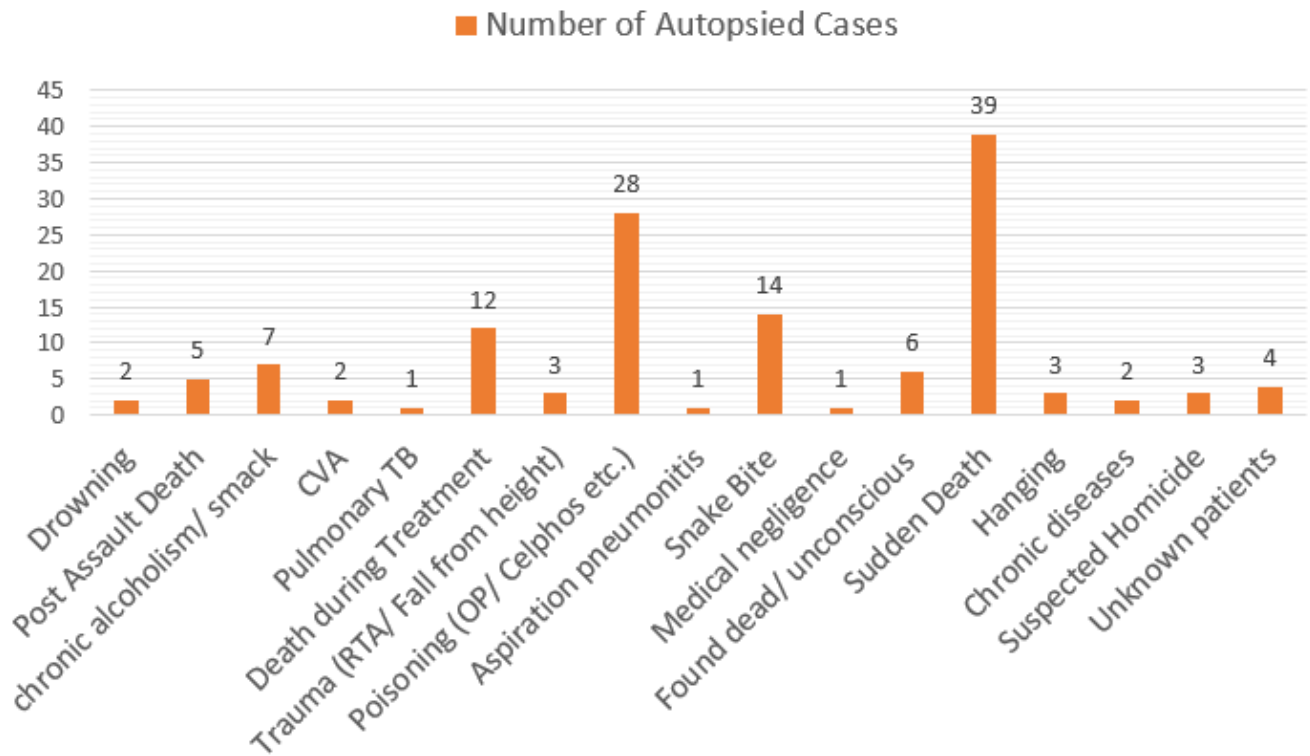
Fig. 5: Overall cause of death distribution of study cases

Table 1: Histopathological spectrumin heart of overall study cases

Pathological Findings	Number of Cases	Percentage
Coronary Artery Disease	56	42.11%
Atherosclerosis of Great Vessels	23	17.29%
Myocardial Hypertrophy	31	23.31%
Ischaemic Heart Disease	20	15.04%
Age Related Changes	10	7.52%
Infective Endocarditis	1	0.75%
Myocardial Calcification	1	0.75%
Ventricular Rupture	1	0.75%
Severe Congestion	10	7.52%
Myocardial Fibrosis	7	5.26%
Myocarditis	1	0.75%
Lad Stent	1	0.75%
Fat Embolism	1	0.75%
Normal	51	38.35%
Autolysed	5	3.76%
Sample Not Received	2	1.50%

Table 2: Age and gender wise distribution of types of atherosclerosis in study population

Age Range (years)	Sex		Atherosclerosis (Type)								Total	
	M	F	1	2	3	4	5	6	7	8	n	%
11-20 years	1	2	-	2	-	1	-	-	-	-	3	4.8%
21-30 years	3	2	1	-	1	2	-	1	-	-	5	7.9%
31-40 years	10	2	1	1	1	5	2	-	2	-	12	19%
41-50 years	15	3	1	1	3	-	6	2	1	4	18	28.6%
51-60 years	14	3	-	3	2	1	5	2	3	1	17	26.98%
61-70 years	5	0	-	1	2	-	-	-	1	1	5	7.9%
71-80 years	1	1	-	-	-	-	2	-	-	-	2	3.2%
>81 years	1	0	-	-	-	-	1	-	-	-	1	1.6%
Total	50	13	3	7	9	10	16	5	7	6	63	100%
Percentage	79.3%	20.6%	4.7%	11.1%	14.2%	15.8%	25.3%	7.9%	11.1%	9.5%		
	Total 100%					Total 100%						

Table 3: Data of Sudden cardiac death (SCD) cases

Hostopathological spectrum of SCD cares		
Pathological Findings	**Number Cases**	**Percentage**
Coronary Artery Disease	23	58.97%
Myocardial Hypertrophy	22	56.41%
Myocardial Infarction	13	33.33%
Myocardial Fibrosis	3	7.69%
Age Related Changes	2	5.12%
Congestion	1	2.56%
Ventricular Rupture	1	2.56%
Normal	5	12.82%
Age distribution in SCD cases		
Age Group	**SCD Cases**	**Percentage**
11-20 years	1	2.57%
21-30 years	3	7.69%
31-40 years	6	15.39%
41-50 years	14	35.90%
51-60 years	13	35.33%
61-70 years	1	2.56%
71-80 years	1	2.56%
>81 years	0	0
Total	39	100%
Gender wise distribution of SCD cases		
Gender	**Sudden Cardiac Death Cases**	**Percentage**
Male	31	79.49%
Female	8	20.51%
Total	39	100%

of age with atherosclerosis showed a significant p value (0.0009) (Table 4). With increasing age, the incidence of atherosclerosis increased from 23% in 2nd decade to 100% in 7th decade. Atherosclerosis was also found in a 15-year-old female. Thus, atherosclerosis begins at a young age and then progresses as age increases. Similar trend has been reported in the earlier studies.[12,13] This clearly indicates that atherosclerosis demands the need for early screening and intervention to avoid its deadly consequences later on. Over all in the age group 10-91 years, males had atherosclerosis prevalence of 50.4% and females of 37.5%. Males showed a slightly higher prevalence than females but

we could not find statistically significant difference because gender distribution in our study population was not equal (Table 4). This result does not tally with most studies on atherosclerosis.

We had total of 20 (15%) cases of M.I. in our study, out of which 3 were acute M.I., 13 were healing M.I. and 4 were cases of healed M.I. Atherosclerosis is the primary cause of MI. 75% MI cases had atherosclerotic plaques. Critical stenosis was defined as narrowing of lumen of coronary artery by 90% or more.[14] Out of total 11 cases of critical narrowing of coronary artery due to atherosclerotic changes, only 45.45% showed changes of M.I. Similarly, study by

Table 4: Comparision of gender and age wise distribution of overall study population and of atherosclerosis cases.

Gender wise Distribution of Cardiac Histology

Gender	Cardiac Histology		P Value
	Normal	Abnormal	
Male	36	65	
Female	13	19	0.6107 (NS)
Total	49	84	

Gender wise distribution of atherosclerosis

Gender	Atheromatous Plaque		P Value
	Present	Absent	
Male	51	50	0.1995 (NS)
Female	12	20	

Age wise distribution of cardiac histology

Age Groups	Cardiac Histology		P Value
11-20 years	8	5	0.0406 (S)
21-30 years	13	12	
31-40 years	12	16	
41-50 years	9	26	
51-60 years	6	17	
61-70 years	0	5	
71-80 years	0	3	
>81 years	0	3	

Age wise distribution of atherosclerosis

Age Groups	Atherosclerosis Plaque		P Value
	Present	Absent	
11-20 years	3	10	0.0009 (S)
21-30 years	5	20	
31-40 years	12	16	
41-50 years	18	17	
51-60 years	17	6	
61-70 years	5	0	
71-80 years	2	1	
>81 years	1	0	

Sree Lakshmi et al[15] showed myocardial infarction in only 50% cases of critical stenosis. In the remaining cases of critical stenosis, probably, characteristic histologic features of myocardial infaction could not develop due to very short time interval between onset of M.I. and death.

In an autopsy study of 40 subjects, Waller et al concluded that increased heart weight was more than 400 grams in men and more than 350 grams in women.[16] Basso et al[17] defined ventricular hypertrophy as cases exceeding the reference range, i.e., a LV wall thickness >1.4 cm and a RV wall thickness >0.5 cm. In present study, same criteria for cardiac hypertrophy were adopted with microscopic confirmation.[18] Myocardial hypertrophy was found in 23.30% cases.

Fibrosis of myocardium was seen in 5.2% cases. The myocardial fibrosis can also be seen in absence of myocardial ischaemia, in conditions such as aging, hypertension, diabetes, dilated/hypertrophic cardiomyopathy, myocarditis, sarcoidosis, chronic renal insufficiency.

We also came across 1 case of transmural rupture of anterior inferior right ventricular wall where microscopy showed extensive fatty infiltration with thinning of myocardium. Though very rare, few similar case reports have been published in literature.[19]

In around 55% cases of sudden deaths, cardiovascular pathology is the cause, making it the most common culprit.[20] In autopsy cases, sudden cardiac death (SCD) has been defined as the sudden, natural unexpected death of unknown or cardiac cause. In unwitnessed cases, it is defined as a person last seen alive and functioning normally <24 h before being found dead and in witnessed cases as an acute change in cardiovascular status with the time to death being <1 h.[21]

SCD cases showed similar histopathological spectrum as all other causes of deaths in our study population, but percentage of each pathology in heart was much higher in SCD cases.

5. Conclusion

Unnatural/ suspicious deaths in a family or society raise an alarm and a thorough postmortem examination is always needed to ascertain cause of death in such cases. The present study shows that heart pathologies make a major contribution towards ill health and death and thus are a pressing health issue in our society.

Atherosclerosis is the most common pathology found in autopsy heart specimen and is responsible for a dominant portion of the chronic illness burden in older adults. Aging is an important risk factor in the development of atherosclerosis. So, preventing atherosclerosis at a young age becomes a major therapeutic opportunity. Also, there are many diseases/ pathological processes like myocardial hypertrophy, myocardial fibrosis which may seem subtle and yet may contribute to the cause of death. These pathologies are usually detected on thorough post-mortem examination of heart only and many times have modifiable risk factors like diabetes and hypertension as their root cause.

There is a general lack of awareness in our society regarding the modifiable cardiovascular risk factors. Cost effective community education schemes should be designed to improve public knowledge regarding importance of life style modifications and preventive measures. Also, newer investigative tools and interventions are a need of time now.

6. Conflict of Interest

None.

7. Source of Funding

None.

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