

A Deep Dive into Morphological and Histopathological Postmortem Cardiac Lesions and their Association with Coronary Artery DiseaseNeeta Avinash Wahane¹, Kalpana B. Rathod², Kshipra S. Patil³, Dhanashri Shinde⁴,
Leena A. Nakate⁵¹Assistant Professor, Department of Pathology, B.J.G.M.C. Pune²Associate Professor, Department of Pathology, B.J.G.M.C. Pune³Junior Resident II, Department of Pathology, B.J.G.M.C. Pune⁴Junior Resident III, Department of Pathology, B.J.G.M.C. Pune⁵Professor and HOD, Department of Pathology, B.J.G.M.C. Pune

Received: 25-12-2023 / Revised: 23-01-2024 / Accepted: 26-02-2024

Corresponding Author: Dr. Kalpana B. Rathod

Conflict of interest: Nil

Abstract:**Background:** Objective was to study the histopathological spectrum of coronary heart diseases in autopsy specimens, that play a major role accounting 80% as cause of death with varying in respect to most common age group affected, single, and double or triple coronary blood vessel involvement. Also includes cardiomyopathy, myocarditis and infective pathology leading to death.**Methods:** This study carried out from January 2022 to November 2023. Total 3199 medicolegal autopsies were received during this period. Out of 3199, specimens of heart were 3166. 45 specimens were Autolysed and 100 were pediatric hearts that were excluded from our study. So, 3021 specimens of heart were included in the study. Gross and microscopic findings on H and E-stained sections were studied.**Results:** Out of 3021 cases, 1987 cases showed atherosclerosis, acute coronary event noted in 12 cases, 394 cases showed features of myocardial infarction, myocardial hypertrophy was found in 114 cases, 10 cases revealed myocarditis, Cardiomyopathy in 6 cases, Myocardial bridging in 3 cases, pericarditis in 4 cases and one case of aortic stenosis. Double vessel atherosclerosis was noted in 196(40.32%). LAD most common followed by RCA in CAD. Out of 501 cases, 167 had no identifiable cause of death even after complete gross and microscopic autopsy was performed.**Conclusions:** Most common cause of death is Coronary artery atherosclerosis which accounting to 65.77%. Leading to myocardial ischaemia in age group 21-60 years is probably the commonest finding in death cases subjected to medicolegal autopsies.**Keywords:** Coronaries, Heart, Post-mortem.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

An estimated 17.7 million Indians died from coronary artery disease (CAD) in 2021. In accordance with the WHO, India accounts for one-fifth of these deaths worldwide especially in younger population. For us Indians particular causes of concern with CVD are early age of onset, rapid progression to sudden death at home without knowing the exact cause the projected death from CAD by 2022 was million. 21.4% diabetic patients with CAD and for non-diabetics it is 11% [1]. In India incidence of ischaemic heart disease has increased to about 10%. [1]

Urban population is more at risk as compared to rural population. Incidence of cardiac deaths has been increasing all over the provides a very important procedure for evaluating causes of death. [2] World heart federation report states that one

third of all deaths due to cardiovascular diseases occur in the age group of 35-64 years in India [3]. Many a time it has been found that when gross pathology could not help to evaluate the cause of death, histopathology can conclusively opine the involved cardiac pathology.

The present study was carried out with an aim to help in final diagnosis of cause of death patients by extracting data from gross and histopathological changes in the heart and the coronary blood vessels. To evaluate the prevalence, grading and distribution of cardiac lesions and correlating them with various risk factors.

Materials and Methods

The present study was carried out at a tertiary care hospital, Pune from January 2022 to November

2023. Total 3199 medicolegal autopsies were received during this period. Out of, 3066 specimens of heart were there. 45 specimens were Autolysed and 100 were pediatric hearts which were excluded from our study. So, 3021 specimens of heart were included in the study in the age group of 21-90 years including both sexes, Epidemiological data and postmortem findings were collected from the post mortem papers and police papers. All the hearts with fixed in 10% formalin. The heart was examined externally to note the size, weight, fat deposition, course of coronary arteries, scars etc. Gross photographs were taken to demonstrate the pathology present.

Gross examination of heart: Weight and dimensions of whole heart were recorded. The external surface was looked for pericardial pathology and for evidence of recent or old infarct. The heart was cut open along the flow of the blood as described by Virchow Method combined with "Bread loaf technique" and sliced at an interval of 1-1.5cm from apex to mid interventricular septum in order to demonstrate infarction or concentric hypertrophy.

Measurement of thickness of right ventricular wall, left ventricular wall and interventricular septum were done. The valves were checked for their number, stenosis and calcification. Regions of either recent or old myocardial ischaemia were checked,

and their location and sizes were recorded. All the three coronary arteries i.e. right coronary artery left anterior descending artery and left circumflex coronary artery were examined using regular sections every 4- 5mm. The ascending aorta was checked for atherosclerosis, aneurysmal dilatation or any anomalies. Autolysed and Pediatric heart specimens were excluded from the study.

Microscopic examination: Sections were taken from right and left atrioventricular junction, right and left ventricular wall, interventricular septum, apex and multiple sections from all the coronary arteries. In addition, sections were taken from suspected pathological lesions. All sections were stained with routine Hematoxylin and Eosin staining and examined under light microscope by using 10x and 40x objectives and results were recorded. In a few cases Masson 's trichome stain was done.

Results

In the present study, 3021 specimens of heart were included. Our series was consisted of cases between 11- 90years old. Maximum number of cases presented between the age group of 21-60years (Table 1). Out of

3021 cases, 2434(79.38%) were male and 632 (20.62%) were female. There was remarkable male dominance (Table 2).

Table 1: Age wise distribution of cases

Range of age in years	No. of patients	%
0-10	0	0
11-20	89	2.94
21-30	601	19.89
31-40	887	29.36
41-50	597	19.76
51-60	486	16.08
61-70	264	8.73
71-80	90	2.97
81-90	5	0.16
Total	3021	100

Table 2: Sex wise distribution of cases

Sex	Number	Percentage (%)
Male	2434	79.38
Female	632	20.62

In histopathological evaluation most, common finding was atherosclerosis (Figure 1) 1987 (65.77%) followed by myocardial infarction (Figure 2, 3) 394 (13.04%) cases, myocardial hypertrophy (Figure 4) 114 (3.77%) cases, myocarditis (Figure 5) 10 (0.33%), pericarditis 4 (0.13%) and one case each of aortic stenosis (Figure 6), Cardiomyopathy in 6 (0.198%) of which dilated cardiomyopathy in 2 and

Hypertrophic Cardiomyopathy in 4. In 501 (16.58%) cases no specific pathological findings are identified during gross and microscopic examination. In heart. (Table 3). Out of 501 cases 167 cases show no findings in other organs except congestion and 334 cases showed non- cardiac causes like Pneumonia, Meningitis, Pulmonary edema etc (Table.3)

Table 3: Histopathological findings

Findings	No of cases	% (out of cases)
Atherosclerosis	1987	65.77
Myocardial infarction	394	13.04
Myocardial Hypertrophy	114	3.77
Acute Coronary event	12	0.39
Myocarditis	10	0.33
Cardiomyopathy	6	0.198
Pericarditis	4	0.13
Aortic stenosis	1	0.03
No specific findings	501	16.58
Total	3021	100

Among 1987 cases which revealed grade II 859 cases (31.32%, 493(25.31%) had Grade III atherosclerotic changes Grade V in 315 (15.85) cases had calcification within the plaque and 54 (2.71%) cases had Grade VI superimposed thrombus formation. (Table 4).

Table 4: Changes in coronaries (out of 1987 cases)

Findings	No of cases	Percentage
Atherosclerosis (Grade II)	859	31.32
Atherosclerosis (Grade III)	503	25.31
Atherosclerosis with cholesterol clefts	493	24.81
Atherosclerosis with calcification (Grade V)	315	15.85
Atherosclerosis with Thrombus (Grade VI)	54	2.71
Total	1987	100

Out of 394 cases of myocardial infarction, 29cases showed acute infarct, whereas 152 cases revealed healing stage of infarct and 213 cases showed Healed Myocardial infarction (Table 5).

Table 5: Types of myocardial infarction (out of 394)

Myocardial infarction	No of cases
Acute	29
Healing stage	152
Healed stage	213
Total	394

Out of 684 cases of Coronary artery atherosclerosis, Left anterior descending coronary artery atherosclerosis was noted in 187(27.33%) followed by which had RCA 157(22.95%) and then LCX had 142(20.76%)Aorta having 198(28.94%)(Table6).

Table 6: Coronary atherosclerosis A) Right Coronary Artery, B) Left circumflex coronary artery. C)Left anterior descending coronary artery.

Atherosclerosis	No of cases
A) Right Coronary Artery	157
B) Left Circumflex Coronary artery	142
C)Left Anterior descending coronary artery	187
D)Aorta	198
Total	684

Out of 486 coronary artery atherosclerosis, double vessel atherosclerosis in 196(40.32%), followed by Single vessel atherosclerosis in 157(32.30%) and then triple vessel atherosclerosis in 133 (27.36%) (Table7).

Table 7: Coronary atherosclerosis A) Single, B) Double C)Triple vessel involvement

Atherosclerosis	No of cases
A)Single vessel	157
B) Double vessel	196
C)Triple vessel	133
Total	486



Figure 1A: Coronary artery atherosclerosis of different grades (I-VI) (H and E X 400). D) with medial calcification, E) with recanalization (H and E X 400).

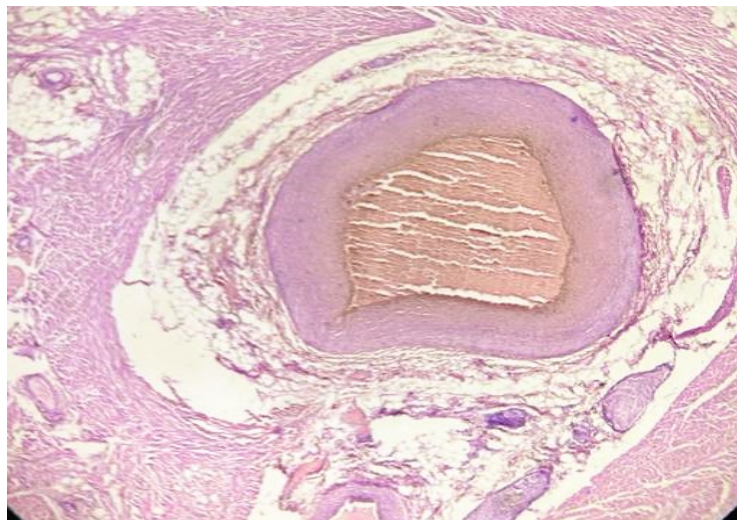


Figure 1B: Myocardial bridging- Coronary artery entrapped in myocardium

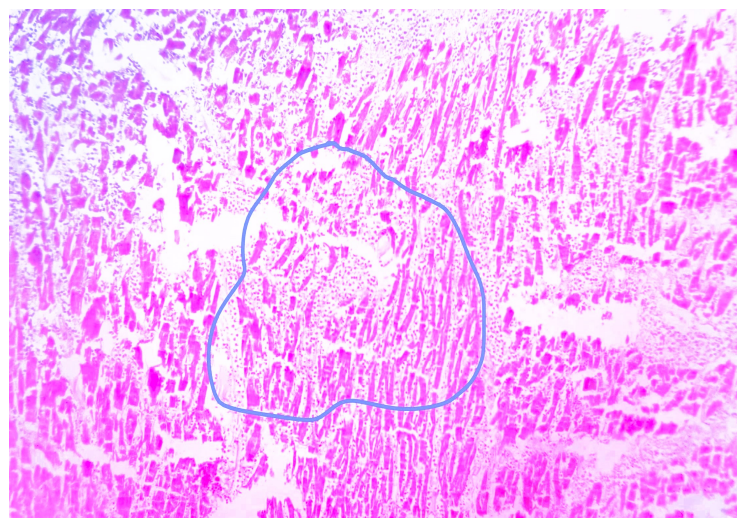


Figure 2: Acute myocardial infarct with coagulative necrosis and dense neutrophilic infiltrate (H and E X 400)

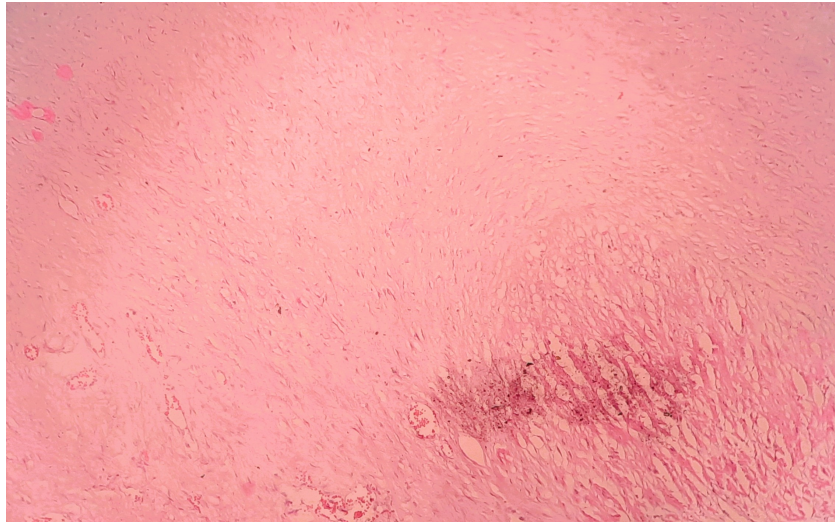


Figure 3: Old myocardial infarct (H and E X 400)

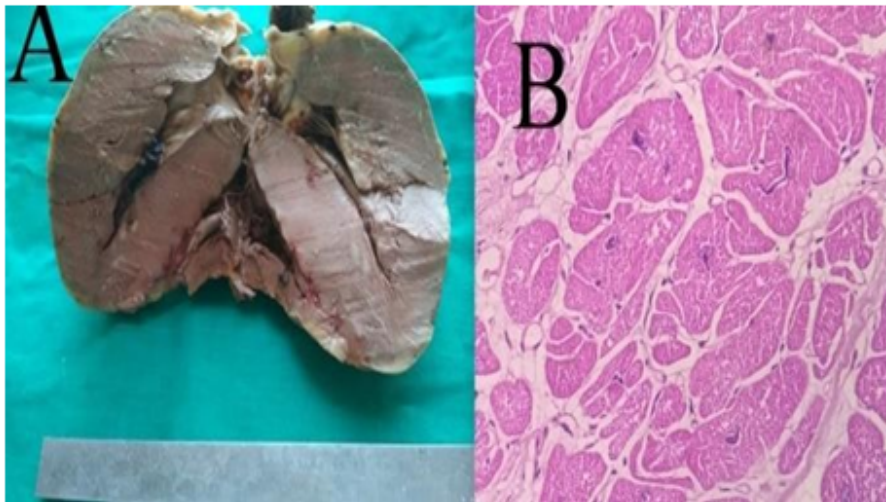


Figure 4: Cardiac hypertrophy A) Gross photograph B) Hypertrophy of myocardial fibres (H and E X200)

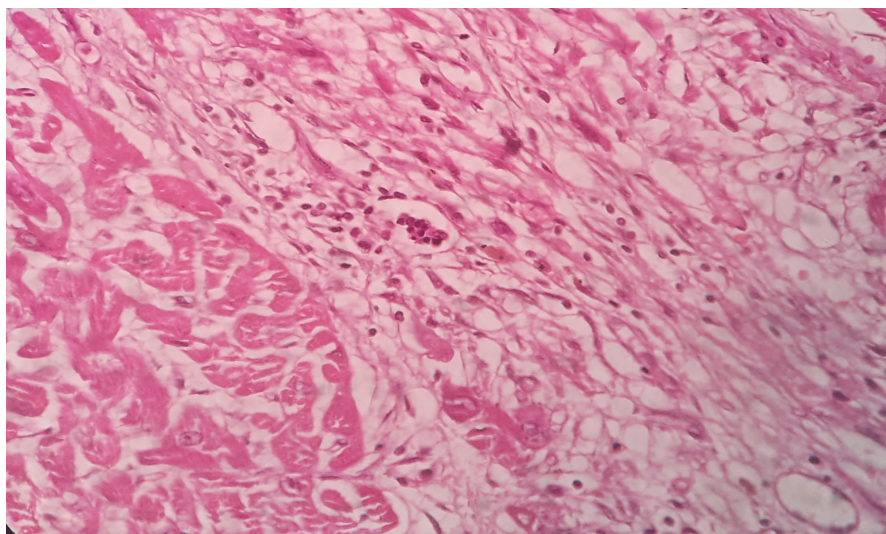


Figure 5: Giant cell myocarditis (H and E X 200).

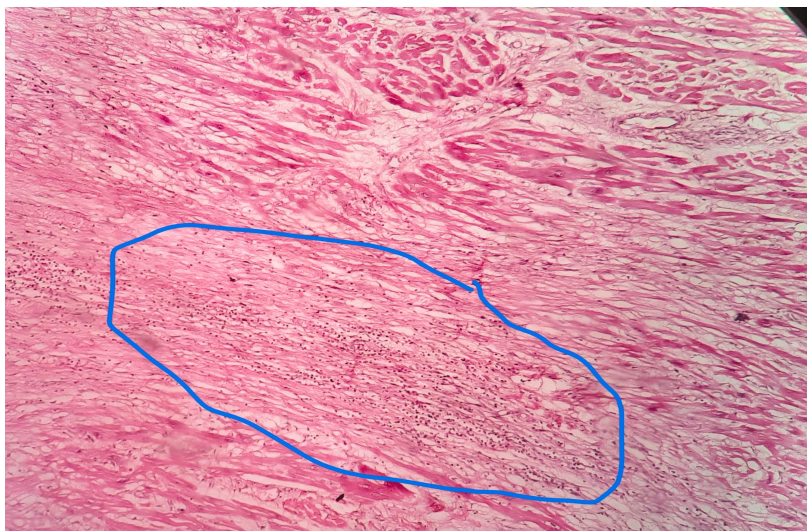


Figure 6: Lymphocytic myocarditis (H and EX400)

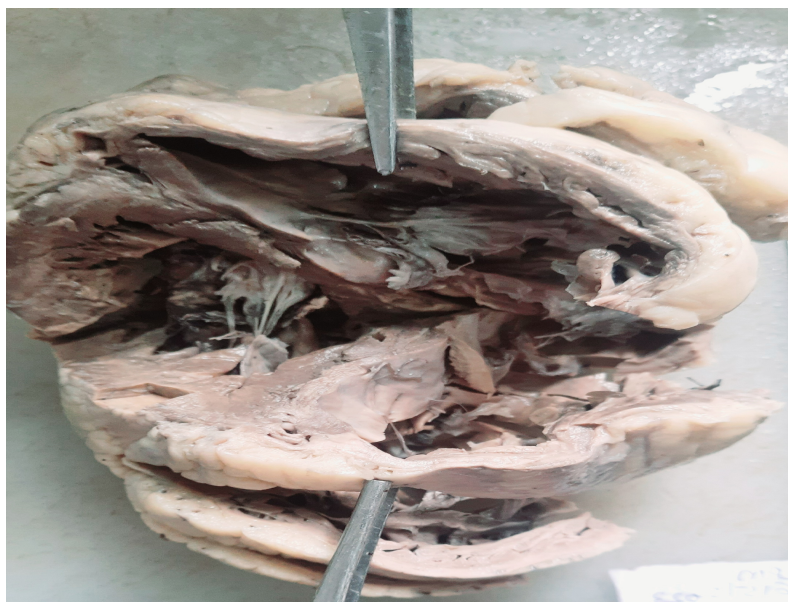


Figure 7: Dilated Cardiomyopathy (gross)

Discussion

The autopsy study provides a means of understanding the basic process which sets a stage for clinically significant atherosclerotic cardiovascular disease. There is no valid method of sampling of living population. It was therefore considered that death suspected due to cardiovascular pathology; probably provide the best sample of the living population for studying cardiovascular diseases. [3] In the present study males were 79.38% and females were 20.62%. This again emphasize that male is at greater risk for heart diseases as compared to females. Male: Female ratio being 3.8:1. This could be due to tobacco and alcohol abuse as compared to females and secondary to protective effect of estrogen hormone in females. Males were commonly affected in the 21-60 years of age group, the minimum age at which CAD was seen was 23

years and the maximum age was 82 years. Similar findings were reported by Ramazan Karanfil et al, 17-78 years and Chandrakala Joshi 41-60years. [2,4] This shows that age is a powerful risk factor for heart disease. The development of atherosclerosis increases markedly with age up to an age of about 65. As per ICMR-INDIAB study, every second individual is physically inactive, BMIs>21kg/m², hypertensive, diabetic, prevalence of current tobacco smoking in males (23.6%) is higher than the global prevalence(22%)¹.

In comparison of histopathological findings in this study, coronary atherosclerosis was most common finding present in 1987(65.77%) cases. Similar findings were reported by Ramazan Karanfil et al, 75%, stavroula A et al, 77% and Chandrakala Joshi 64%.^{2,4,5} Calcification was present in 315(15.85%) cases and thrombus in 54(2.71%) The most common coronary artery affected by

atherosclerosis was the Left anterior descending coronary artery (187 cases). The most common atherosclerotic grade was Grade II (31.32%), which was in co-ordinance with the study carried out by Md Ibrahim Siddiqui et al. [12]. Our study reported 54 (2.71%) cases with grade VI atherosclerosis with thrombus formation. Similarly thrombosis was reported in 4.8% cases Bora Ozdemir et al [6].

Out of 486 coronary artery atherosclerosis, double vessel atherosclerosis was noted in 196(40.32%) followed by Single vessel atherosclerosis in 157 (32.30%) and then triple vessel in 133(27.36%). Acute coronary event with critical single or double coronary critical narrowing almost 90-100% was seen in 12 cases, Since such patients died suddenly hence no microscopic evidence of myocardial infarction. Myocardial bridging seen in 3 cases mostly in the age group of 21-30 years. Plaque calcification is found more frequently in advanced lesions, it may also occur in small amounts in earlier lesions, which appear in second and third decade of life. Histopathological investigations had shown that plaques with microscopic evidence of mineralization are larger. However, the relation of arterial calcification to the probability of plaque rupture is unknown. [3]

In this study histological evidence of myocardial infarction was present in 394(13.04%) cases, similarly Bora Ozdemir et al, reported myocardial infarction in 26% cases. [6] Ramazan et al, reported myocardial infarction in 48% cases, which is higher than our study whereas Wang HY, et al, reported ischaemic heart disease in 7% cases, which is lower than the present study. [4,7] This difference may be due to time variability between onset of ischaemia and time of death. Because microscopic features depend upon the time period between onset of ischaemia and death. Next common lesion in this study was myocardial hypertrophy which was present in 114 (3.77%) cases. Grossly 41 cases showed the heart weighed more than 400grams, 18 cases the heart weighed > 480 grams and in 5 cases heart weighed >600 grams in 5 cases, >700 grams in 2 cases and = 600 grams in 3 cases. and In the literature, similar incidence that is 7% was reported by Cristino Basso et al, and Wang HY et al. [7,8] Ramazan Karanfil et al, and Chandrakala et al, reported a much higher incidence of cardiac hypertrophy in 66% and 52% cases respectively. [2,4]

Myocarditis was found in 10 (0.33%) cases. We had reported one case of giant cell myocarditis and 1 case of tuberculous myocarditis, 6 lymphocytic of which one was HIV positive and 2 acute myocarditis (neutrophilic infiltrate) Variable percentage of myocarditis has been reported by different authors. Chandrakala Joshi 9%, Cristina Basso et al, 10%, Bora Ozdemir et al, 7%, Drory et al, 25% and Kramer et al, 29%. [6,8-10] In the

present study pericarditis was found in 4 (0.13%), 1 case of fibrinous pericarditis was association with Acute myocardial infarction. Whereas Chandrakala Joshi reported pericarditis in only 0.86% cases. 2 Primary pericarditis is uncommon, it is mostly secondary to infection. Viruses are usually responsible. [11] In this study, 4 cases of Hypertrophic cardiomyopathy with massively enlarged heart weighing more than 600 grams in the age group of 20-30 years. The wall thickness of heart was increased with significant myocardial hypertrophy without dilatation of the ventricles and ventricle septal thickening, microscopically showing areas of interstitial fibrosis, marked hypertrophy of cardiac myocytes along with focal disarray of myocytes which was in co-ordinance with the study carried out by Md Ibrahim Siddiqui et al. [12] And 2 cases of Dilated Cardiomyopathy with enlarged heart weighing more than 450 grams, thinned out ventricular walls and dilated and dilatation of ventricles. Cardiovascular diseases constitute the most common cause of sudden death.

It is well known that lifestyle modification and drug therapy in selected individuals can reduce the risk of cardiac events, but current Framingham risk assessment is suboptimal. No significant cardiac and other organs changes noted in 167 cases mostly males in the age group of 21-30 years, can be of primary electrical conduction defect died suddenly with patent coronaries and unremarkable myocardium. We need to investigate such cases family history and genetic study to confirm the diagnosis. So in medicolegal autopsies it is proposed that every possible organ must be sampled for histopathological examination and must be examined with a multidisciplinary approach (scene investigation, medical history, biochemical, microbiological, toxicological etc.). Histopathology of various organs is very helpful to the forensic surgeons in arriving at a conclusion regarding the cause of death.

Conclusion

To conclude, Histopathological studies provide the most accurate clues to a better understanding that most common cause of death is coronary artery atherosclerosis which accounting to 65.77% in the present study, leading to myocardial ischaemia in age group 21-60 years With better insight into disease pathophysiology, all efforts are required to proactively taken to clearly understand the role of risk factors in emerging epidemic. Lifestyle modification and screening from younger age could be introduced to improve care and future outcomes for patients undergoing cardiovascular diseases. This study adds valuable data to the literature regarding the morphology of atherosclerotic lesions.

Acknowledgements: Authors would like to acknowledge Autopsy section (Pathology) and forensic medicine (faculty, technical staff) at tertiary care centre, which helped.

References

1. A. Sreenivas Kumar and Nakul Sinha. Cardiovascular disease in India:A 360 degree overview. Med J.armed Forces India 202 Jan 76(1):1-3
2. Rao D, Sood D, Pathak P, Dongre SD. A cause of sudden cardiac deaths on autopsy findings: a four year report. Emergency. 2014; 2(1):12-7.
3. Joshi C. Postmortem study of histopathological lesions of heart in cases of sudden death- an incidental finding. J Evid Based Med Healthc. 2016; 3(6):184-8.
4. Abedinzadeh N, Pedram B, Sadeghian Y, Nodushan SMHT, Gilasgar M, Darvish M, et al. A Histopathological Analysis of the epidemiology of coronary atherosclerosis: An autopsy study. Diagn Pathol. 2016; 2(11)127.
5. Karanfil R, Gulmen MK, Hilal A. Evaluation of cardiac conduction system in sudden death cases. J For Med. 2013; 27(1):17-28.
6. Ozdemir B,Celbis O. Onal R. multiple organ pathologies in underlying in sudden natural deaths. Medicine Science. 2012;1(1):13-26.
7. Wang HY, Zhao H, Song LF. Pathological study of unexpected sudden death clustered in family or village in Yunnan province: report of 29 cases of autopsy. Zhonghua Yi Xue Za Zhi 2007; 87(31):2209-14
8. Basso C, Calabrese F, Corrado D. Postmortem diagnosis in sudden death victims; macroscopic, microscopic and molecular findings. Elsevier, cardiovascular research. 2001;50:290-300.
9. Drory Y, Turetz Y, Hiss Y. Sudden unexpected deaths in person less than 40 years of age. Am J. Cardiol. 1991;68:1388-92.
10. Kramer MR, Drory Y, Lev B. Sudden death in young. Israeli Solidiers analysis of 83 cases. Isr. J. Med Sci. 1989;25:620-4.
11. Kumar. Abbas, Fausto.Robbins basic pathology Indian Reprint: 8th Edition: ISBN: 978-81-312-1036-9Page No. 416.
12. Md Ibrahim Siddiqui, Anita A Mahanta, SR Umesh, Saara Neeha, Sainath K Andola., Morphological study of the spectrum of lesions encountered in the heart and coronaries on autopsy. Indian J. Pathol Microbiol 2022Oct (3): 65:18-22.