



Original Research Article

Histopathological Spectrum of Cardiac Lesions in Sudden Death: An Autopsy-Based Study from the Mahakaushal Region of Central India.

Name of Author:		Abstract: Background: Sudden cardiac death (SCD) is a major global public health problem and constitutes a large proportion of medicolegal autopsies. In India, data from semi-rural regions remain limited, and many cardiovascular pathologies go undiagnosed during life. Objectives: To evaluate the histopathological spectrum of cardiac lesions in sudden deaths, assess age- and sex-wise distribution, and correlate gross and microscopic cardiac findings. Methods: This autopsy-based observational study was conducted on sudden death cases received at a tertiary care center in the Mahakaushal region of Madhya Pradesh, India. Hearts were examined grossly and sampled systematically from the left ventricle, interventricular septum, right ventricle, and coronary arteries. Histopathological evaluation was performed using hematoxylin and eosin staining. Results: Cardiovascular pathology was identified in the majority of sudden deaths, with ischemic heart disease and coronary atherosclerosis being the predominant findings. The left anterior descending artery was most frequently involved. Acute myocardial infarction showed coagulative necrosis, wavy fibers, edema, and neutrophilic infiltration, while chronic ischemic injury was characterized by fibrosis and collagen scar formation. Males in the 41–60-year age group were most commonly affected. Gross findings such as cardiomegaly, left ventricular hypertrophy, and coronary stenosis showed strong correlation with histopathological abnormalities. Conclusion: Coronary atherosclerosis and myocardial ischemic injury are the leading histopathological substrates of sudden cardiac death in the Mahakaushal region. Autopsy with detailed microscopic examination remains indispensable for accurate cause-of-death determination and for identifying silent cardiovascular disease in the community.
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INTRODUCTION

Sudden death is defined by the World Health Organization as death occurring within 24 hours of the onset of symptoms or in the absence of a previously recognized fatal condition.¹ Among natural causes, cardiovascular diseases account for the majority of sudden deaths, particularly ischemic heart disease, myocardial infarction, arrhythmias, and cardiomyopathies.^{2–4}

Sudden cardiac death (SCD) is a devastating

manifestation of cardiovascular disease and often occurs without prior warning. In older adults, coronary artery disease (CAD) and acute myocardial infarction (AMI) are the dominant causes, whereas in younger individuals myocarditis, hypertrophic cardiomyopathy, and inherited arrhythmogenic disorders assume greater importance.^{3,5}

Autopsy and histopathological examination are crucial in the evaluation of sudden deaths. Gross examination may identify cardiomegaly, coronary stenosis, or

myocardial scars, but microscopic analysis is essential for detecting early ischemic changes, myocarditis, fibrosis, and subtle cardiomyopathies that may not be apparent macroscopically.^{6,7}

India is witnessing a major epidemiological transition, with cardiovascular diseases emerging as the leading cause of mortality.⁸ However, most available data are derived from urban hospital-based studies. Semi-rural regions such as Mahakaushal in Madhya Pradesh face unique challenges, including limited access to healthcare, delayed diagnosis, and underreporting of sudden deaths.⁹ Consequently, the true burden and histopathological spectrum of SCD in such regions remain inadequately characterized.

The present study was undertaken to evaluate the histopathological changes in the heart among sudden death cases in the Mahakaushal region, analyze demographic patterns, and correlate gross and microscopic findings. The study aims to provide region-specific autopsy-based evidence that may help improve cause-of-death accuracy and inform preventive cardiovascular strategies.

MATERIALS AND METHODS

Study design and setting

A descriptive autopsy-based observational study was conducted at the Department of Pathology in collaboration with the Department of Forensic Medicine of a tertiary care teaching hospital in the Mahakaushal region of Madhya Pradesh, India.

Study population

All medicolegal autopsy cases fulfilling the criteria for sudden death during the study period were included. Sudden death was defined as death occurring within 24 hours of symptom onset or unexpected death in an apparently healthy individual.

RESULTS

Demographic profile

The majority of sudden death cases were males, with the highest incidence occurring in the 41–60-year age group. Male predominance was observed across almost all age categories.

Age group (years)	Male	Female	Total
≤20	2	1	3
21–40	11	3	14
41–60	28	7	35
>60	15	5	20
Total	56	16	72

Gross cardiac findings

Cardiomegaly and left ventricular hypertrophy were common gross findings. Significant coronary artery stenosis was observed predominantly in the left anterior descending artery.

Gross finding	Cases (n)	Percentage (%)
Cardiomegaly	29	40.3
Left ventricular hypertrophy	21	29.2
Coronary atherosclerosis	48	66.7

Inclusion criteria

1. Sudden natural deaths subjected to complete medicolegal autopsy.
2. Cases in which the heart was available intact for gross and microscopic examination.

Exclusion criteria

1. Deaths due to trauma, poisoning, burns, drowning, or other clearly unnatural causes.
2. Decomposed bodies with autolysis precluding histopathological evaluation.
3. Cases with incomplete autopsy records or unavailable tissue samples.

Gross examination

After fixation in 10% buffered formalin, the heart was examined for weight, dimensions, wall thickness, chamber dilatation, valve abnormalities, and pericardial changes. The coronary arteries were dissected serially and assessed for atherosclerosis, calcification, stenosis, and thrombosis.

Histopathological examination

Representative tissue sections were taken from the left ventricle, interventricular septum, right ventricle, papillary muscles, and coronary arteries. Sections were processed routinely, embedded in paraffin, and stained with hematoxylin and eosin. Histological parameters evaluated included myocardial necrosis, edema, hemorrhage, inflammatory infiltrates, fibrosis, granulation tissue, myocyte hypertrophy, and vascular pathology.

Data analysis

Clinical and autopsy data were compiled and analyzed descriptively. Age- and sex-wise distributions were calculated, and correlations between gross and microscopic findings were assessed qualitatively.

Coronary stenosis >75%	27	37.5
Acute thrombus	14	19.4
Pericardial abnormality	3	4.2
Valvular abnormality	2	2.8

Histopathological findings

Ischemic myocardial injury constituted the dominant microscopic pattern. Both acute and chronic infarct changes were encountered.

Histopathological finding	Cases (n)	Percentage (%)
Acute myocardial infarction	31	43.1
Chronic ischemic fibrosis/scar	24	33.3
Myocarditis	5	6.9
Cardiomyopathy	4	5.6
Conduction system fibrosis	2	2.8
No significant microscopic lesion	6	8.3

Acute myocardial infarction showed coagulative necrosis, wavy myocardial fibers, edema, and neutrophilic infiltration. Chronic infarcts demonstrated fibrocollagenous scar formation and myocyte loss. Myocarditis was characterized by lymphocytic infiltration and focal myocyte necrosis.

Correlation between gross and microscopic findings

Gross coronary stenosis and cardiomegaly showed strong association with histological evidence of ischemic injury. Cases with severe LAD stenosis frequently demonstrated acute infarction or chronic fibrotic changes microscopically. Conversely, a small subset of cases with minimal gross abnormalities revealed myocarditis or conduction system fibrosis only on histopathology.

IMAGES:

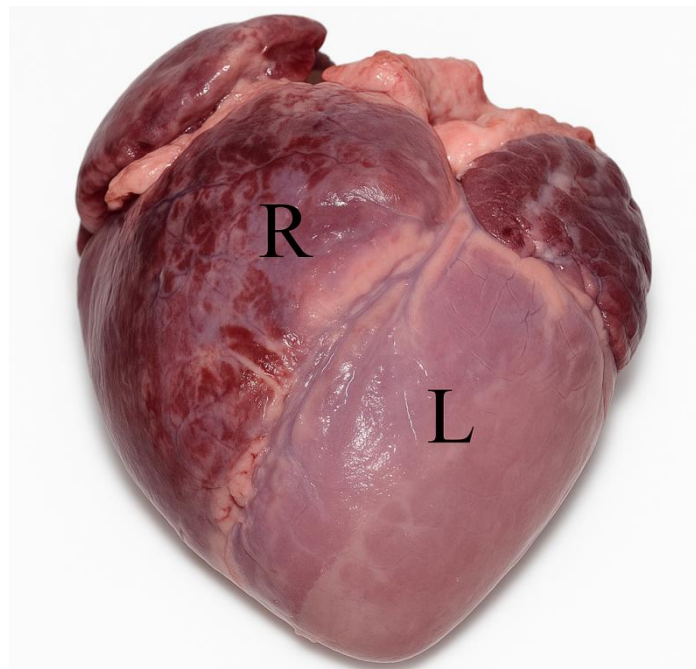


Figure 1- SUBEPICARDIAL HEMORRHAGES IN 36YEAR FEMALE



Figure 2 -CHRONIC MYOCARDIAL INFARCTION IN 43YEAR OLD MALE

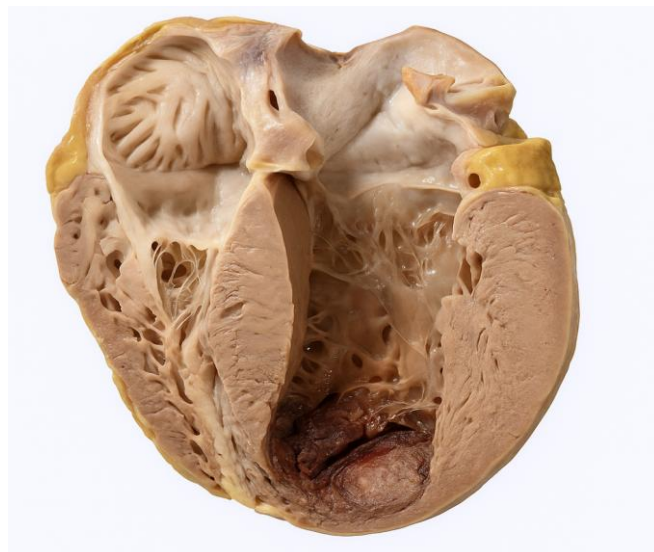


Figure 3 - BIVENTRICULAR HYPERTROPHY WITH THROMBUS AT APEX IN 62 YEAR OLD MALE

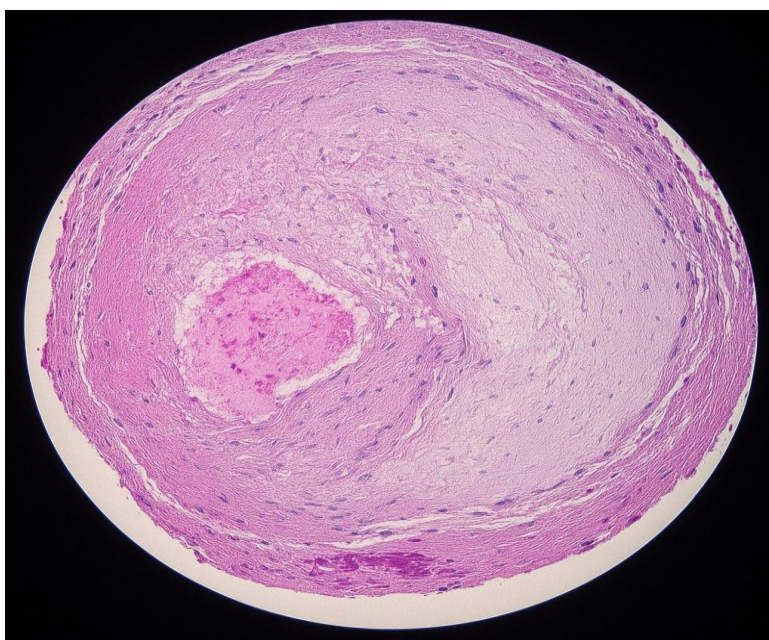


Figure 4 - MICROSCOPIC IMAGE SHOWING ATHEROMATOUS PLAQUE.

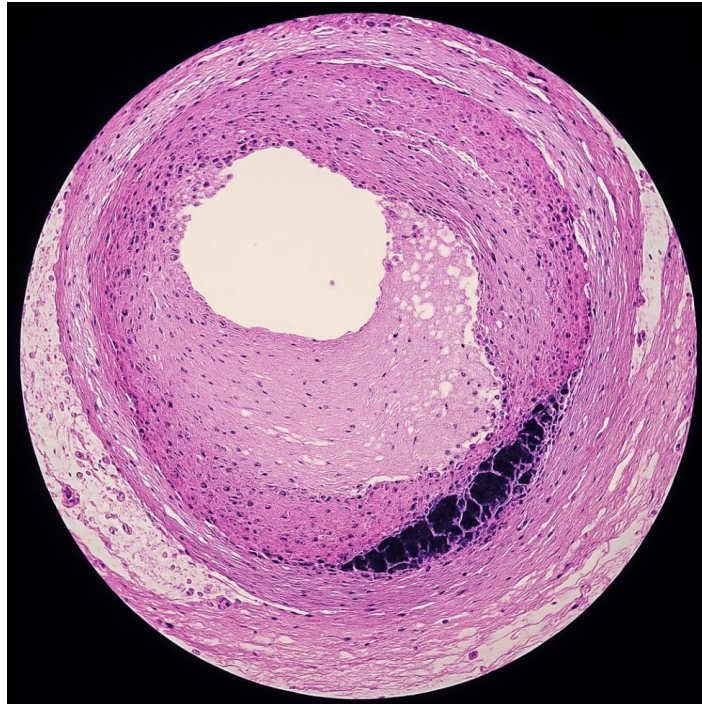


Figure 5 - MICROSCOPIC IMAGE SHOWING CORONARY ARTERY (LAD) WITH LARGE ATHEROMATOUS PLAQUE CONTAINING CENTRAL RICH CORE

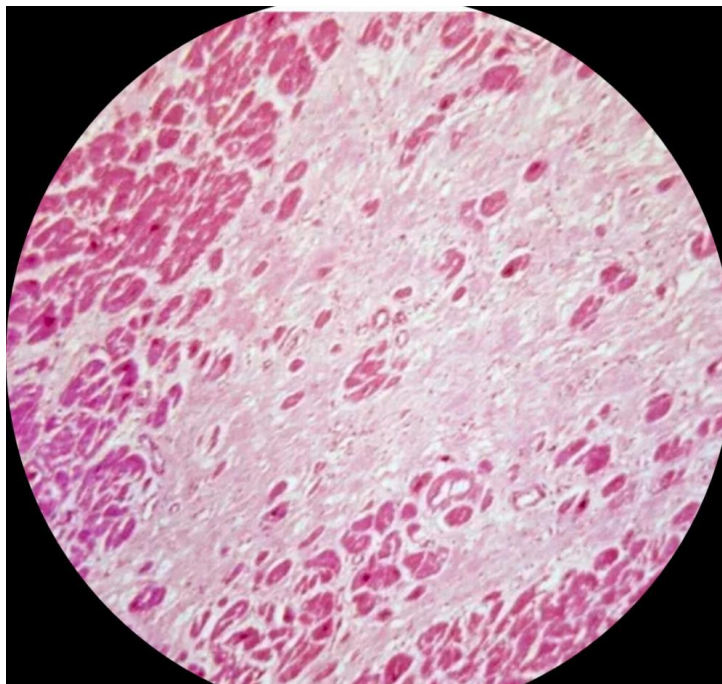


Figure 6 - MICROSCOPIC IMAGE SHOWING HEALED MYOCARDIAL INFARCT WITH DENSE COLLAGEN SCAR TISSUE BETWEEN MYOCYTES

DISCUSSION

The present study demonstrates that ischemic heart disease and coronary atherosclerosis are the predominant pathological substrates of sudden cardiac death in the Mahakaushal region. These findings are consistent with earlier autopsy-based studies from India

and abroad, which report coronary artery disease as the leading cause of SCD.^{10–13.}

A marked male predominance was observed, particularly in the fifth and sixth decades of life. Similar

demographic patterns have been documented in studies from Odisha, Punjab, and Karnataka.^{14–16} The higher prevalence among middle-aged males may reflect greater exposure to conventional cardiovascular risk factors such as smoking, hypertension, diabetes, and occupational stress.

Coronary atherosclerosis was identified in two-thirds of the cases, with the left anterior descending artery being the most frequently affected vessel. This mirrors observations by Hoon et al., Tikare et al., and Burke et al., who also reported predominant LAD involvement in sudden cardiac deaths.^{10,11,17} Severe coronary stenosis and plaque-related thrombosis were common in our series, supporting the central role of acute coronary events in fatal arrhythmogenesis.

Histopathologically, acute myocardial infarction showed classical features including coagulative necrosis, wavy fibers, edema, and neutrophilic infiltration. These findings correspond closely with the infarct chronology described by Vora et al. and Huculak et al.^{18,19} Chronic ischemic injury manifested as interstitial fibrosis and fibrocollagenous scarring, indicating prior silent infarctions or longstanding ischemia. Such scars can serve as arrhythmogenic substrates even in the absence of acute thrombosis.

Myocarditis and cardiomyopathies accounted for a smaller but clinically important proportion of cases, especially among younger individuals. Similar observations have been reported by Nayar et al., Basso et al., and Corrado et al., who emphasized the role of inflammatory and non-ischemic myocardial diseases in sudden death among the young.^{20–22} In several of our cases, these lesions were not obvious grossly and were detected only on microscopic examination, underscoring the indispensability of histopathology.

The correlation between gross and microscopic findings was generally strong for ischemic heart disease. Cardiomegaly, ventricular hypertrophy, and coronary stenosis frequently corresponded to myocardial fibrosis or infarction. However, a subset of cases with minimal gross abnormalities revealed significant microscopic pathology, particularly myocarditis and conduction system fibrosis. This highlights an important limitation of relying solely on gross autopsy findings.

From a public health perspective, the predominance of preventable ischemic heart disease is noteworthy. Semi-rural regions such as Mahakaushal often lack systematic cardiovascular screening and timely access to care. Autopsy studies therefore provide valuable epidemiological insight into the hidden burden of cardiovascular disease in the community.

CONCLUSION

This autopsy-based study demonstrates that coronary atherosclerosis and ischemic myocardial injury are the

leading histopathological causes of sudden cardiac death in the Mahakaushal region of Central India. The left anterior descending artery is the most commonly affected coronary vessel, and males in the 41–60-year age group constitute the most vulnerable population.

Gross examination alone may miss clinically significant lesions such as myocarditis and conduction system fibrosis. Therefore, detailed histopathological evaluation of the heart should be considered essential in all sudden death autopsies.

The findings emphasize the need for improved cardiovascular risk assessment, early screening, and preventive healthcare strategies in semi-rural Indian populations.

Limitations

1. Single-center study with a relatively limited sample size.
2. Lack of complete clinical histories and risk-factor profiles in some cases.
3. Advanced ancillary investigations such as immunohistochemistry, toxicology correlation, and molecular autopsy were not available for all cases.

Future Directions

Future multicentric studies incorporating molecular autopsy, genetic testing for inherited arrhythmia syndromes, and detailed clinical correlation are needed to better define the spectrum of sudden cardiac death in Indian populations.

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