Original Article

Histological Classification of Atherosclerosis and Correlation with Ischemic Heart Disease: A Autopsy Based Study

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ABSTRACT

Background: There is an ever increasing trend of rise of coronary artery disease (CAD) in India and globally. The grading of coronary atherosclerotic lesions is important as it correlates with significant cardiac lesions like acute myocardial infarction (MI), myocardial fibrosis and left ventricular hypertrophy (LVH) etc. To study the same in living subjects is difficult, hence autopsy studies are done. Our 1 year retrospective study aims at grading the coronary atherosclerotic lesions and correlating the results with simulating studies in India and abroad.

Method: The present study was conducted in the Department of Pathology, JLN Medical College, Ajmer (Rajasthan). Duration of study was from January 2011 to December 2011. Total 103 post-mortem heart specimens, irrespective of cause of death were examined grossly and microscopically for extent of coronary artherosclerosis and associated cardiac lesions.

Results and Conclusion: Of the 103, males affected was 74.75% and females was 25.24%. Commonest type of atherosclerosis was type III (preatheroma) 40.7%. 55.33% showed significant coronary artery disease (type IV -VIII) with atheroma (type IV) as the commonest lesion (23.30%).

Left anterior descending artery (LADA) was most frequently involved vessels (46.6%) followed by right coronary artery (RCA) involvement (41.71%). Least frequently involved vessel was left circumflex artery (LCX) (38.83%). 15% had single vessel involvement whereas 37% & 40% cases had two vessels and three vessels involvement respectively.

Maximum cases of significant cardiac lesions were associated with advanced atherosclerotic lesions ie. type VI & type VII lesions. Eccentric lesions were more common than concentric lesions.

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Introduction

Ischemic heart disease (IHD) is defined as acute or chronic form of cardiac disability due to imbalance between supply and demand of oxygenated blood. In more than 90% cases the cause of myocardial ischemia is reduced blood flow due to coronary atherosclerosis. Thus IHD is often termed coronary artery disease (CAD) or coronary heart disease (CHD). [1]

CAD is the leading cause of global deaths with about 80% of burden occurring in developing countries [2,3]. In India, CAD has emerged as the single largest disease accounting for nearly one third of all deaths. The incidence of coronary artery disease has doubled during past three to four decades. A total of nearly 6.4 crore cases of coronary artery disease are likely in the year 2015, nearly 96% would be coronary heart disease cases. An estimated 1.3 million Indian died from this in 2000 [4]. The projected deaths from coronary artery disease by 2015 is 2.95 million, of which 14% will be under 30 years and 31% will be under 40 years[5].

The exact global incidence of atherosclerosis is not possible to calculate because it can exist without producing any signs & symptoms. An autopsy study gives a good measure of the prevalence, grading and distribution pattern of atherosclerotic lesions.

In order to assess the magnitude of coronary atherosclerosis, a retrospective study of autopsy cases for the presence of atherosclerotic lesions of coronary arteries and associated ischemic cardiac lesions like acute myocardial infarction (MI) / myocardial fibrosis MF) / left ventricular hypertrophy (LVH) was under taken for a period of 1 year from January 2011 to December 2011.

Materials and Methods

The present study was conducted in the Department of Pathology, JLN Medical College, Ajmer (Rajasthan) for a period of 1 year from January 2011 to December 2011. Total 103 postmortem heart specimens, irrespective of cause of death (natural, unnatural or sudden death) were examined grossly and microscopically for presence & extent of coronary atherosclerosis and evidence of acute myocardial infarction / myocardial fibrosis / left ventricular hypertrophy. Autolytic specimens were excluded from the study. The medical history and clinical diagnosis before death in view of the cases were unavailable.

The heart was fixed in 10% formalin, weighed and biopsied within 4-24 hours of fixation using standard autopsy protocol of heart grossing. Thickness of right & left ventricular wall was measured. The three main coronary arteries were dissected out, exposed transversely and longitudinally and examined for thickening (concentric/ eccentric), yellow streaks calcification, rupture, etc. Ventricles were sectioned transversally at 10 mm intervals starting from apex. Gray-white areas suspicious of infarction / fibrosis were identified and taken.

After routine processing & paraffin embedding 4µ sections were taken and stained with H&E. All the sections were examined microscopically for the presence of atheroma and myocardial infarction / fibrosis. According to American Heart Association, Typing of atherosclerotic plaques was done [6,7].

Type I: Isolated intimal foamy cell (minimal change)

Type II: Numerous intimal foamy cells often in layers (fatty streaks)

Type III: Pools of extracellular lipids without a well defined core (intermediate lesion or preatheroma)

Type IV: Well defined lipid core with luminal surface covered by normal intima (atheroma or fibroplaque)

Type V: Lipid core with a fibrous cap with or without calcification (fibroatheroma)

Type VI: Fibroatheroma with cap defect such as haemorrhage or thrombosis

Type VII: Calcification prominent

Type VIII: Fibrous tissue change prominent

The stenosis of coronaries is graded based on the luminal narrowing of the coronaries and is graded from grade 0 (normal) to grade IV (complete obstruction).

Grade 0 : Normal

Grade I : 1-25% stenosis

Grade II : 26-50% stenosis

Grade III : 51-75% stenosis

Grade IV : 76-100% stenosis

Results

Total heart specimens received in the Department of Pathology were 131. Out of these, 26 specimens were autolysed. All the subjects were grouped into specific age groups based on the age at the time of death. The different age groups and sexes were correlated with the degree of atherosclerosis (Table-1)

The youngest case was 15 years female and the oldest was 80 years male forming a age range of 15-80 years. Mean age was 39.38 years. Mean age for males was 40.92 years and for females was 35.59 years. (Table-1). Of the 103 heart studied, 74.75% were males quite higher than females (25.24%) forming a ratio of 3:1. (Fig.1).

Commonest prevalent atherosclerotic lesion was type III (preatheroma) 40.7%. Significant coronary artery disease (type IV -VIII) was seen in 55.53% cases (Fig. 2, 3) with atheroma (type IV) as a common lesion 23.30%. (Table-1)

In cases with significant coronary artery disease LADA (left anterior descending artey) was most frequently involved vessels in 46.6% cases followed by RCA (right coronary artery) in 41.71% cases. Least frequently involved vessel was LCX (left circumflex artery) in 38.83%. (Table-2)

Among the 103 cases 15% had single vessel involvement whereas two vessels and three vessels were involved in 37% & 40% cases respectively.

The effect of myocardial ischemia due to coronary atherosclerosis in terms of acute myocardial infarction was 19 cases (18.44%) (Fig. 4), myocardial fibrosis 15 cases (14.56%) (Fig. 5) & left ventricular hypertrophy 24 cases (23.30%). (Table-3) Maximum cases were seen between 41-60 years of age with a mean age of 49.79_years. Male to female ratio was 3.75:1. Theses cardiac lesions were associated with advanced atherosclerotic lesions ie. grade VI & grade VII (Table 4). Eccentric lesions were more common than concentric lesion with a ratio of 1:2.16.

The mean weight of cardiac heart was 303.88 gms, slightly more in males 305.04 gms than females 291.29 gms.

DISCUSSION

There is an alarming increase in the morbidity and mortality due to coronary atherosclerosis in India. There is no valid method for sampling of living population. The autopsy study provides a means of understanding the basic process which sets a stage for clinically significant atherosclerotic cardiovascular disease. Though our study involved only a small number of cases, most of our observation correlated with many similar studies.

In the present study, the overall incidence of significant atherosclerosis was found to be 55.33%, comparable to Shirani et.al [8] (65%) and McGill et al[9] (58%) study.

Atherosclerosis begins in childhood & progress to form the lesions that causes coronary heart disease. Males have a relatively preponderance of coronary artery disease than females until the menopause. Oestrogen in females

TABLE 1: Correlation of typing of coronary atherosclerosis with age

Age Group (Years)	Type II n	Type III n	Type IV n	Type V n	Type VI n	Type VII n	Type VIII n
11-20	3	8	-	-	-	-	-
21-30	-	15	5	2	1	-	-
31-40	-	12	9	3	1	-	-
41-50	1	3	8	1	4	3	-
51-60	-	3	2	6	2	1	1
61-70	-	1	-	1	3	3	-
71-80	-	-	-	1	-	-	-
Total	4	42	24	14	11	7	1
%	3.8	40.7	23.3	13.5	10.6	6.7	0.97

Table 2: Frequency distribution of atherosclerosis in three major coronary vessels

TYPE	LADA		RCA		LCX	
	n	%	n	%	n	%
II	8	7.76%	11	10.67%	15	14.56%
III	47	45.63%	49	47.57%	48	46.60%
IV	23	22.33%	22	21.35%	20	19.41%
V	10	9.70%	13	12.62%	11	10.67%
VI	11	10.67%	3	2.91%	7	6.79%
VII	3	2.91%	5	4.85%	2	1.94%
VIII	1	0.97%	-	-	-	-
IV to VIII Grade	48	46.60%	43	41.71%	40	38.83%
TOTAL	**103**		**103**		**103**	

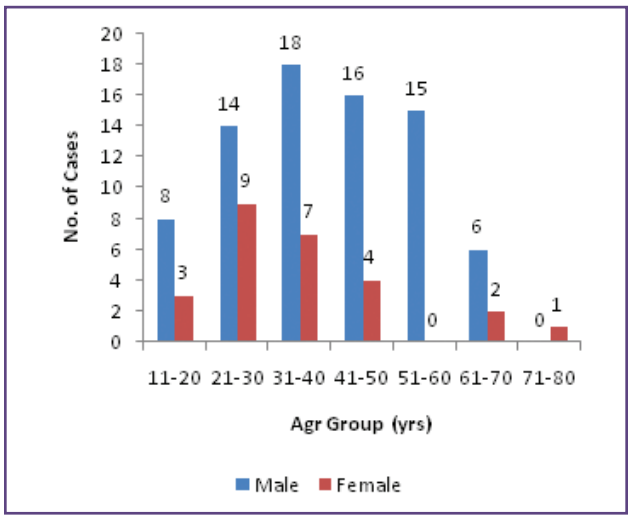

Fig. 1. Age and sex distribution of 103 autopsied cases

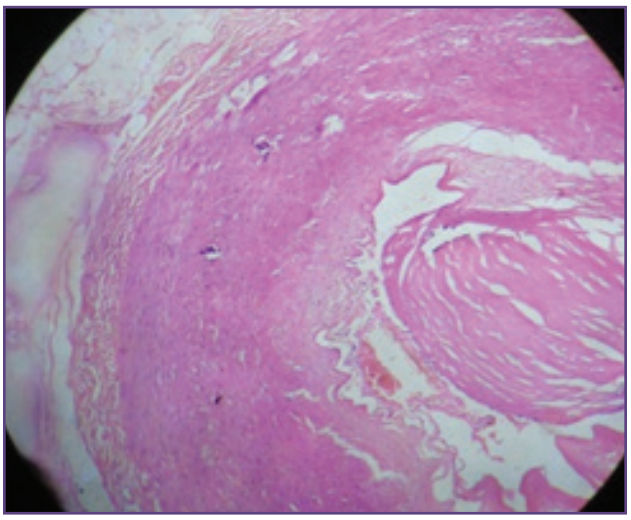

Fig. 3 : Fibroatheromatous plaque showing organized thrombus in the lumen (Type VI,Grade IV) H&E, 100X

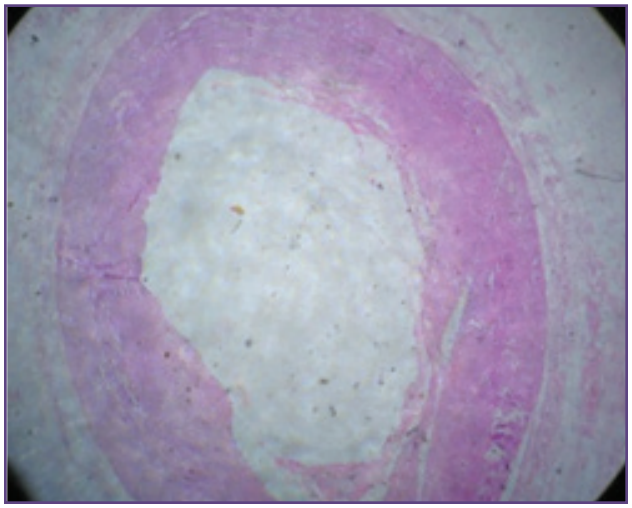

Fig. 2: Concentric atheromatous plaque showing well defined lipid core (Type IV, Grade II) H&E, 40X

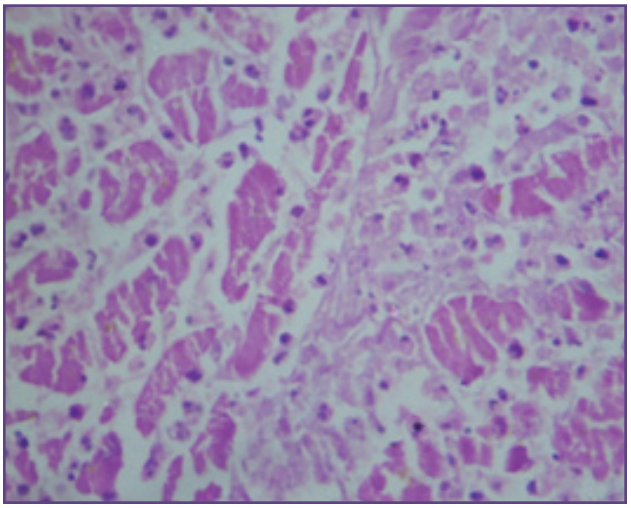

Fig. 4 : Myocardial infarction showing mycytonecrosis with abundant neutrophils H&E, 400X

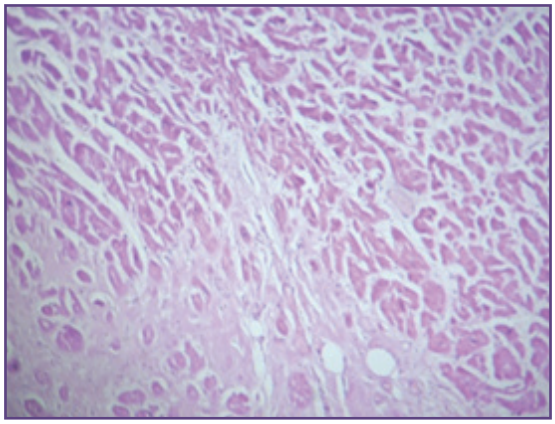

Fig. 5 : Myocardial fibrosis showing areas of fibrosis in myocardium H&E 400X

Table 3 : Correlation of significant cardiac lesions with age

Age Group (Yrs)	Myocardial Infarction	Myocardial fibrosis	Left ventricular hypertrophy
21-30	1	1	3
31-40	2	1	4
41-50	7	5	8
51-60	6	5	5
61-70	3	3	4
Total	**19 (18.44%)**	**15 (14.56%)**	**24 (23.30%)**

TABLE 4 : Correlation of significant cardiac lesions with degree of atherosclerosis

Atherosclerosis typing	Myocardial Infarction	Myocardial Fibrosis	Left ventricular hypertrophy	Total	Percentage
Type II	-	1	-	1	1.72%
Type III	1	-	1	2	3.44%
Type IV	2	3	7	12	20.68%
Type V	2	3	3	8	13.79%
Type VI	8	5	8	21	36.20%
Type VII	5	2	5	12	20.68%
Type VIII	1	1	-	2	3.44%

have protective effect against atherosclerosis. Moreover, males are more indulged in alcoholism and drinking explaining male preponderance towards development of atherosclerosis. In our study males were affected more (74.75%) than females (25.24%) comparable to other studies done. Garg M et al[4] found coronary atherosclerosis lesions in 80.9% males (93 cases) as compared to 19.1% females (22 cases). Bhargava & Bhargava [10] also reported more prevalence in male 74.8% than females 24.2%.

Age group in different studies varied from neonates to 90 year. In our study it was 15 year to 80 year. No case was found in the first decade. The 3rd decade of life appeared to be a watershed line in the pathogenesis of coronary vascular atherosclerosis. Dhruv et al.[11], Garg M et al [4] also reported increased frequency of atherosclerosis from 3rd decade onwards. Stressful, sedentary lifestyle, lack of exercise and poor dietary habits are the important factors for early initiation and development of atherosclerosis in young generation.

American Heart Association classified atherosclerotic lesion from type I to type VIII. It was proposed that these lesions progressed from one type to the next. In our study commonest prevalent lesion was preatheroma (40.7%) similar to study of Garg M et al who also showed preatheroma as a commonest lesion (30.9%) [4]. However Dhruv et al [11] showed more cases of atheroma (27.4%) followed by preatheroma (23.8%).).

But significant coronary artery disease showed atheroma as the commonest lesion (23.30%). These findings correlate to those reported by Virmani et al (37.5%) [12] and Farb et al. (33%) [13]

Evidence of coronary involvement in LADA, RCA & LCA was 46.60%, 41.71% and 38.83% respectively which was in concordance with the data given by Sudha et al.[14] who showed LADA as the commonest site for plaque formation (47%), followed by RCA (40%) and LCA (38.1%). Garg M et al [4] also showed the most common involvement of LADA (38.1%) followed by RCA (35.1%) and LCA (34%).

In our study triple vessel involvement was the commonest (40%) followed by double and single vessel involvement 37% &15% respectively. It was correlated with the study given by Garg M et al. [4] who also reported triple vessels was the most commonly involved vessels (44.4%). However, Virmani et al. [12] showed single vessel involvement was greater than others (44%).

Ischemic heart disease due to CAD is mainly caused by atherosclerosis . In general slowly developing coronary atherosclerosis of high grade (fibroatheroma) may not cause acute lesions but complications in atherosclerotic plaque in the form of superimposed coronary thrombosis due to plaque rupture or thrombosis may lead to acute attack. Those patients who survived attack showed changes of chronic myocardial ischemia in the form of

focal or diffuse myocardial fibrosis, so small areas of fibrous scarring are found in elderly patients who have history of attacks of MI years back. Hearts from patients with chronic IHD are usually enlarged and heavy, due to left ventricular hypertrophy and dilation. Myocardial hypertrophy represents compensatory mechanism to meet the cardiac demand as hypoxia is produced by significant coronary atherosclerosis.

In our study maximum cases of ischemic heart diseases were seen between 4th-5th decade of life with a mean age of 49.79 years. These lesions were associated with advanced atherosclerotic lesions ie. grade VI & grade VII. Acute MI was seen in 18.44% cases comparable with the observation reported by Bharti Jha et al. (12.3%) [15] and Shiladaria P et al (22.5%)[16].

The average weight of the heart was greater in atherosclerotic heart (303.88 gms) comparable to 327 g by Bertomeu et al. [6]. This is due to increased cardiac work and compensatory myocardial hypertrophy. As atherosclerosis was found to be more in males, the average weight of the male hearts was more than those of female hearts. In our study it was found to be 305.04 gms for males and 291.29 gms for females. Our finding are comparable to the similar finding of Dhruva et al. [11] and Garg M et al.[4] who too found that the average heart weight in males was higher as compared to females.

Conclusion

This study showed unexpectedly high prevalence of atherosclerosis in Ajmer, Rajasthan especially in the relatively young population. Though the incidence of atherosclerois is more common in males as compared to females but in both sexes it is alarming.

The study of human atherosclerotic lesion is an extremely difficult task in a living subject and an autopsy study is the best possible way to work on it. Our study aids valuable data to the literature regarding the morphology of atherosclerotic lesion and its relation to the significant cardiac lesion.

This study highlights a need of life style change in general public and also calls for screening programmes and prevention and control measures against atherosclerosis from early age.

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