Original Article

An Autopsy Study of Histopathological Examination of Coronary Atherosclerosis by Modified American Heart Association Classification in a Tertiary Care Centre

Aesha Amrish Parikh, Hemina Himanshu Desai*, Rutul Amrish Parikh, Twinkle Bhashyantkumar Thakkar, Bhumi Rameshchandra Bhuva, Hansa Goswami

Pathology Department, B.J. Medical College and Civil Hospital, Asarva, Ahmedabad, Gujarat, India

DOI: 10.21276/APALM.3338

***Corresponding Author**:
Dr Hemina Himanshu Desai
hemina@ymail.com

Submitted: 29-Mar-2024
Final Revision: 03-Jun-2024
Acceptance: 07-Jun-2024
Publication: 11-Jul-2024

This work is licensed under the Creative Commons Attribution 4.0 License. Published by Pacific Group of e-Journals (PaGe)

Abstract

Background: The study was conducted to assess the atherosclerotic lesions in coronary arteries in autopsy cases, grading them with reference to the Modified American Heart Association (AHA) classification. It also aimed to evaluate atheromatous plaques to determine the age and sex-related prevalence of atherosclerosis at B.J. Medical College, Ahmedabad.

Methods: Autopsies were conducted on 100 cases between the ages of 10-75 years, during the period from January 2023 to July 2023, using conventional techniques. A microscopic assessment of two main coronary arteries was performed.

Results: According to the Modified AHA classification of atherosclerosis, the maximum number of cases belonged to the 40-49 years age group (46 cases), followed by the 21-39 years age group (29 cases). Out of the 100 cases, 85 were male and 15 were female. The degree of atherosclerosis in the left coronary artery (LCA) was greater in comparison to the right coronary artery (RCA). Pathological intimal thickening (PIT), intimal thickening (non-atherosclerotic), and calcified nodules were common lesions found in these coronaries. PIT was the most common lesion involving the coronaries and is the precursor lesion for the development of advanced lesions.

Conclusion: Coronary artery disease is reaching pandemic proportions, so the study of subclinical atherosclerosis is crucial to estimate the disease burden in the asymptomatic population. Autopsy-based studies for evaluating the prevalence of atherosclerosis in a population are cost-effective procedures and help in estimating the future disease burden in the population.

Keywords:

Atherosclerosis, Autopsy, Coronary artery disease, Atheromatous plaque

Introduction

Cardiovascular disease (CVD) has emerged as a major health burden worldwide, with atherosclerosis being the major cause of it. Ischemic heart disease (IHD) following atherosclerosis is the most common cause of cardiac deaths worldwide [1]. Cardiovascular diseases (CVDs) have become the leading cause of mortality in India. A quarter of all mortality is attributable to CVD. Ischemic heart disease and stroke are the predominant causes, responsible for over 80% of CVD deaths. The Global Burden of Disease

study estimates an age-standardized CVD death rate of 272 per 100,000 population in India, which is higher than the global average of 235 per 100,000 population [2]. In India, there is a wide variation in race, geographic factors, dietary habits, lifestyle, and tobacco and alcohol usage among the population. Therefore, the epidemiological study of specific populations is of great importance [3]. The Indian population is affected by atherosclerosis with more advanced lesions at a younger age than in other ethnic groups [4].

As the study of atherosclerosis in the living population is difficult, invasive, and expensive, especially in developing countries, autopsy studies have proved to be a good method for assessing atherosclerosis [5]. Identifying the prevalence of sub-clinical atherosclerosis in a population helps health administrators plan preventive measures and strategies to prevent death at a young age [6]. Very few studies have applied the modified American Heart Association classification of atherosclerosis based on morphological descriptions for the assessment of atherosclerosis in the Indian population [1]

Materials and Methods

This study was conducted on 100 cases of autopsy between the ages of 10-75 years, at B. J. Medical College and Civil Hospital, Ahmedabad, from January 2023 to July 2023. This is an autopsy study where demographic data regarding the lifestyle of subjects and pre-existing medical conditions were not available. The hearts were examined grossly, weighed, and fixed in a 10% buffered formalin solution. Measurements of the right ventricular wall, left ventricular wall, and inter-ventricular septa were taken. Coronary arteries were dissected along the flow of blood. The Left Coronary Artery (LCA) and Right Coronary Artery (RCA) were dissected longitudinally, and each coronary artery was sectioned at 3 mm intervals to examine for any atherosclerotic plaques.

The coronary artery segments with grossly visible thickening in the wall, narrowing of the lumen, or gritty sensation on cutting due to calcification were especially selected for further processing and microscopic examination. The coronaries were examined grossly for the presence of thrombus, narrowing of the lumen, atherosclerotic plaque, and calcification.

Tissue bits were taken from the LCA and RCA from gross atherosclerotic lesions as well as suspicious lesions for the microscopic assessment of atherosclerosis. If no lesions were found, random tissue bits were taken from the above-mentioned sites. After routine tissue processing and paraffin embedding, sections of 4-5 micrometers were cut by a rotary microtome. Haematoxylin and eosin staining of all the sections was done. Microscopic grading of atherosclerosis was done using the Modified American Heart Association (AHA) Classification of Atherosclerosis as shown in Table 1.

Results

In the present study, 100 hearts were examined. The age of the subjects ranged from 10 to 75 years. The maximum number of cases belonged to the 40-49 years age group (46), followed by 21-39 years (29). Out of the 100 cases, 85 were male and 15 were female. The degree of atherosclerosis in the left coronary artery (LCA) was greater in comparison to the right coronary artery (RCA). Pathological intimal thickening (PIT), intimal thickening (non-atherosclerotic), and calcified nodules were common lesions found in these coronaries. PIT was the most prevalent among all the lesions. The LCA showed the highest number of PIT cases (15), followed by 12 cases of calcified nodules, compared to the RCA. There was an equal prevalence of thin fibrous atheroma in both coronaries. The maximum number of non-atheromatous lesions, i.e., intimal thickening, was seen in the RCA.

Males have more atherosclerotic lesions compared to females. PIT is the most common lesion involving the coronaries, which is the precursor lesion for the development of advanced lesions.

Table 1 :The Modified American Heart Association (AHA) Classification of atherosclerosis [3.]

Description		Thrombosis
Non atherosclerotic lesions		
Intimal thickening	The normal accumulation of Smooth Muscle Cells (SMCs) in the intima in the absence of lipid or macrophage foam cell.	Absent
Intimal xanthoma or "fatty streak"	Luminal accumulation of foam cells without a necrotic core or fibrous cap. Based on animal and human data, such lesions usually regress.	Absent
Progressive atherosclerotic lesions		
Pathological intimal thickening	SMCs in a proteoglycan rich matrix with areas of extracellular lipid accumulation without necrosis	Absent
Erosion	Luminal thrombosis; plaque same as above	Thrombus mostly mural and infrequently occlusive
Fibrous cap atheroma	Well –formed necrotic core with an overlying fibrous cap	Absent
Erosion	Luminal thrombosis; plaque same as above; no communication of thrombus with necrotic core	Thrombus mostly mural and infrequently occlusive
Thin fibrous cap	A thin fibrous cap infiltrated by macrophages and lymphocytes with Rae SMCs and an underlying necrotic core.	Absent,; may contain intraplaque hemorrhage /fibrin
Plaque rupture	Fibroatheroma with cap disruption; luminal thrombus communication with the underlying necrotic core	Thrombus usually occlusive
Calcified nodule	Eruptive nodular calcification with underlying fibrocalcific plaque	Thrombus usually nonocclusive
Fibrocalcific plaque	Collagen rich plaque with significant stenosis usually contains large areas of calcification with few inflammatory cells; a inflammatory cells; a necrotic core may be present	Absent

Table 2: Distribution of cases in Age & sex wise distribution.

Age group	Male	Female	Total	Percentage
0-20 years	2	1	3	3%
21-39 years	20	9	29	29%
40-59 years	44	2	46	46%
60 years and above	19	3	22	22%
Total	**85**	**15**	**100**	**100%**

Table 3: Coronary Artery based distribution, according to Modified AHA classification of atherosclerosis based on morphological description

Lesion	Right coronary artery	Left coronary artery
Intimal thickening (non atherosclerotic)	17	7
Intimal Xanthoma	7	7
Pathological Intimal Thickening(PIT)*	13	15
PIT + Erosion	5	7
Fibrous Cap Atheroma (FCA)**	5	8
FCA + Erosion	7	6
Thin Fibrous Atheroma	10	10
Plaque Rupture	3	3
Fibrocalcific Plaque	3	9
Calcified Nodule	11	12
Nil	19	16
Total	**100**	**100**
*PIT - Pathological Intimal Thickening , ** FCA- Fibrous Cap Atheroma		

Table 4: Distribution of atherosclerosis in gender according to Modified AHA classification based on morphological description

No. of gender cases	Type of atherosclerosis	Percentage of coronaries involved.(%)
Males (85%)	Non atheromatous	14.11
	Pathological intimal thickening	14.11
	Advanced lesions	71.76
Females (15%)	Non atheromatous	40
	Pathological intimal thickening	13.33
	Advanced lesions	46.66

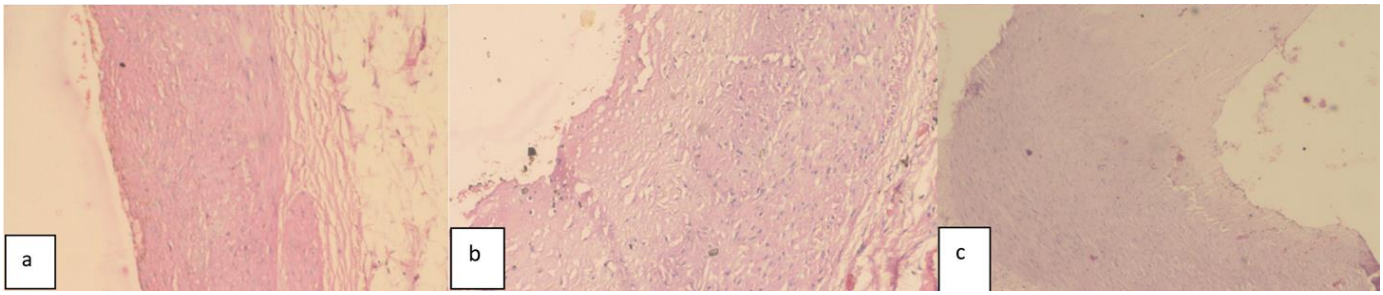

Figure 1: The microphotograph of Hematoxylin & Eosin stain shows: a) non-atheromatous intimal thickening in a coronary artery [10x], b) pathological intimal thickening in a coronary artery [20x], and c) a fibrous cap atheroma with erosion in a coronary artery [10x].

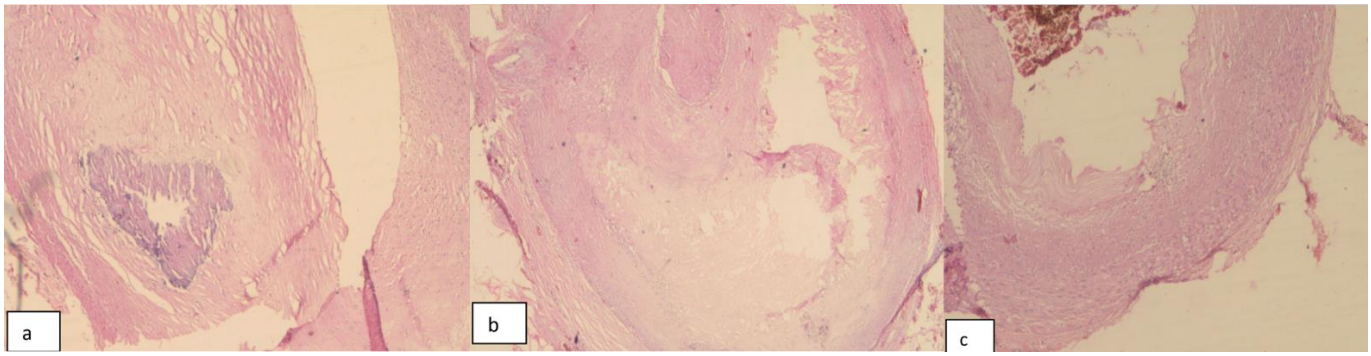

Figure 2: The microphotograph of Hematoxylin & Eosin stain shows: a) a calcified nodule in a coronary artery [10x], b) a fibrocalcific plaque with complete occlusion in a coronary artery [10x], and c) a thin fibrous cap atheroma in a coronary artery [20x].

Discussion

Epidemiology: Cardiovascular diseases are major causes of mortality and disease in the Indian subcontinent, causing more than 25% of deaths. It has been predicted that these diseases will increase rapidly in India and that this country will be host to more than half the cases of heart disease in the world within the next 15 years. Coronary heart disease and stroke have increased in both urban and rural areas [7].

Evolution & Pathophysiology: Atherosclerosis is a disease of the arterial wall that consists of a gradual, lifelong continuum of histological changes characterized by lipid retention, oxidation, and modification, which provoke chronic inflammation, ultimately

causing thrombosis or stenosis. In the natural course of atherosclerosis, spontaneous regression of early-stage lesions may occur, but the intermediate and advanced stages appear to be continuously progressive [8].

Reporting – Classification: The modified AHA classification is used since it offers better categorization of atherosclerotic lesions based on morphological descriptions compared to the earlier AHA classification, which was not useful in subdividing the intermediate lesions of atherosclerosis. Defining these intermediate lesions, which have pools of extracellular lipid, is of great importance as they are an indicator of progression to advanced atherosclerotic lesions. The occurrence of erosion and thrombus formation even with intermediate lesions like pathological intimal thickening is noteworthy, as it can lead to thrombus formation followed by sudden cardiac death even in the absence of advanced atherosclerotic lesions. Progressive atherosclerotic lesions like thin fibrous cap atheromas (TFCA) carry a higher chance of rupture and thrombosis with consequent obstruction of blood flow in the coronaries, causing IHD [1].

Gender Distribution: In the present study, it was observed that 85 cases (85%) were males and 15 cases (15%) were females, which is concordant with the studies by Bhanvadia et al. (64% males and 36% females) and Thej et al. (66.37% males and 33.62% females) [3, 1].

Anatomical Distribution: In the present study, the degree of involvement of atherosclerosis in the LCA (70%) was more compared to the RCA (54%). Our study is concordant with the study done by Bhanvadia et al., showing LCA (40%) and RCA (39%) involvement but differed from Yazdi et al., showing involvement of the RCA (50%) more compared to the LCA (42.5%) [3, 9].

Frequency of Type of Lesions According to Modified AHA Classification: In the present study, the percentage of coronaries with atherosclerosis having PIT (14.11%) and advanced lesions (71.76%) was higher in males compared to females with PIT (13.33%) and advanced lesions (46.66%). This is not in concordance with Bhanvadia et al. (32% and 27%; 35% and 17%) and Thej et al. (39% and 23%; 32% and 18%) [3, 1]. Whereas the percentage of coronaries with non-atheromatous lesions in our study is higher in females (40%) compared to males (14.11%), which is similar to Bhanvadia et al. (48% and 41%) and Thej et al. (50% and 48%) [3, 1].

Preventive Measures and Public Health Implications: Our autopsy study, having limitations of details on demographic data of the patients, leads to potential shortcomings in the treatment of the patients due to the lack of knowledge about previous interventions and medications. This can cause difficulties for the doctor in concluding the pathological outcomes on the patients. Although CVD risk factors are widely prevalent in India, there are significant variations between and within different regions. This heterogeneity can be attributed to diversity in culture (leading to differences in dietary practices, tobacco use, and physical activity patterns) and variations in economic development between and within different states in India.

The emergence of the CVD epidemic in India poses a great challenge to its health systems. The decline in cardiovascular mortality can be driven by population-level changes in common risk factors and medical therapies, with more than half of the reduction in mortality attributed to improvements in population-level risk factors like tobacco use, cholesterol, and blood pressure. To the best of our knowledge, there are no data evaluating macroeconomic policy changes and non-personal interventions on CVD in India. However, modeling studies suggest that substantial benefits could be gained by imposing taxes on tobacco, palm oil, and sugar-sweetened beverages in India. Effective policy-level changes need community acceptance through communication of behavioral changes and health promotion [2].

Limitations and Suggestions for Further Implications: Our study was autopsy-based, and no demographic data regarding

lifestyle factors and pre-existing medical conditions were available. Thus, it was not possible to conclude on this particular aspect or on various preventive measures. No information regarding cardiovascular risk factors such as lipid profiles, blood glucose levels, or any past cardiac disease was available for the individuals autopsied. To overcome this limitation in a large country like India, with considerable urban-rural lifestyle and habit differences, as well as socio-regional diversity, we need to conduct large multi-centre prospective long-term follow-up studies of CAD and atherosclerosis.

CAD is attaining pandemic proportions, so the study of subclinical atherosclerosis is needed to estimate the disease burden in the asymptomatic population. Risk factor reduction is crucial in managing young CAD patients (males > females) to prevent complications or premature death, which lead to a huge financial burden on the health sector of India.

Conclusion

Classification by the modified AHA criteria provides an estimate of disease advancement and plaque vulnerability. Autopsy-based studies for identifying the prevalence of atherosclerosis in a population are cost-effective and help in estimating the future disease burden. This facilitates proper planning of preventive measures and ensures they are directed at the right population. An increased prevalence of atherosclerosis was found in males compared to females, indicating that preventive measures, screening of cardiovascular risk factors, lifestyle modification, and changes in dietary habits should be instituted early in young Indians. We recommend that detailed demographic data, including lifestyle factors like smoking and alcohol use, and information on various medical conditions like hypertension and diabetes, should be included in the case notes accompanying the autopsy form. The government may also consider policies such as banning certain modifiable factors, viz. alcohol and smoking, involved in coronary artery disease.

Acknowledgement: *I would like to extend my gratitude to Dr. Hansa Goswami (Professor & Head of the Department of Pathology, BJMC), who gave me this opportunity. I am grateful to my guide, Dr. Hemina Desai (Associate Professor), and my colleagues for their thoughtful intervention. I would also like to thank all my teachers and laboratory staff for their support.*

Funding: None

Competing Interests: The authors declare that they have no conflict of interest.

Statement of Ethical approval for the study: Ethical approval was taken from college ethical committee.

References

1. Thej MJ, Kalyani R, Kiran J. Atherosclerosis in coronary artery and aorta in a semi-urban population by applying modified American Heart Association classification of atherosclerosis: An autopsy study. J Cardiovasc Dis Res. 2012 Oct-Dec;3(4):265–71.
2. Prabhakaran D, Jeemon P, Roy A. Cardiovascular Disease in India: Current Epidemiology and Future Directions. Circulation. 2016;133:1605-20.
3. Bhanvadia VM, Desai NJ, Agarwal NM. Study of coronary atherosclerosis by modified American Heart Association classification of atherosclerosis: An autopsy study. J Clin Diagn Res. 2013;7(11):2494-7.
4. Puri N, Gupta PK, Sharma J, Puri D. Prevalence of atherosclerosis in coronary artery and thoracic artery and its correlation in North-West Indians. Indian J Thorac Cardiovasc Surg. 2010;26:243–6.
5. Naher S, Naushaba H, Muktadir G, Rahman MA, Khatun S, Begum M. Percentage area of intimal surface of the abdominal aorta affected by atherosclerosis: A Postmortem Study. J Med Sci Res. 2007;9:26–30.
6. Curtiss LK. Reversing Atherosclerosis? N Engl J Med. 2009;360:1144–6.
7. Gupta R, Joshi PP, Mohan V, et al. Epidemiology and causation of coronary heart disease and stroke in India. Heart. 2008;94:16–26.

8. Burke AP, et al. Healed plaque ruptures and sudden coronary death: evidence that subclinical rupture has a role in plaque progression. Circulation. 2001;103:934–40.
9. Yazdi SAT, Rezaei A, Azari JB, Hejazi A, Shakeri MT, Shahri MK. Prevalence of atherosclerotic plaques in autopsy cases with noncardiac death. Iran J Pathol. 2009;4(3):101–4.