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**Original Article**

# Autopsy based morphometric study of Coronary atherosclerosis in various aged dead bodies

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**Abstract:**
***Background and objectives:*** This research has been carried out on all the autopsies performed at a teaching hospital, satisfying the inclusion criteria with an objective to ascertain the presence or absence of atherosclerotic disease of the coronary blood vessels.
***Method***: This is a histological study done on 445 heart specimens in the department of forensic medicine for a period of one year, irrespective of cause of death, age and sex to evaluate the presence of coronary atherosclerosis.
***Results***: Out of the 445 specimens of hearts examined, the most commonly affected coronary blood vessel was the LAD. No atherosclerotic changes were noted in 32 heart specimens examined which belonged to individuals between 18 years to 45 years. Triple vessel disease was also encountered in many cases that were asymptomatic. Out of 31 cases of natural death, coronary artery disease was found in all the cases, in varying grades and death due to coronary insufficiency due to CAD was found in 9 cases. The higher grades of coronary artery atherosclerosis were found more towards advanced age group. Males were more commonly affected than the females.

**Keywords**: Coronary atherosclerosis, AHA grading of atherosclerotic disease, natural death, patency of coronary artery.

## INTRODUCTION

The disease atherosclerosis has great relevance today. Atherosclerosis is a distinctive form of arteriosclerosis known from ancient times. The terms ‘athere’ (meaning-porridge) and sclerotic (hardening or fibrosis) derived from Greek terminology do not represent the complete morphology of the disease. An atheromatous plaque is an intimal depositwhich consists of a raised lesion with a soft grumous core of lipid (mainly cholesterol and cholesterol esters) covered by a fibrous cap and at times, evidence of hemorrhage and calcium deposits1. Atherosclerosis leading to ischemic heart disease (IHD) is the most common cause of cardiac deaths worldwide. The exact global incidence of atherosclerosis is impossible to calculate because it can exist without producing any symptoms or signs. These asymptomatic cases can be diagnosed only if an autopsy is done, in all cases of death due to any cause. Assessment of atherosclerotic lesions in living subjects is difficult and almost nonexistent due to its invasive nature and can be an expensive enterprise. Hence, autopsy-based study of coronary vessels and aorta, has emerged as an invaluable tool for studying these atherosclerotic lesions in deceased subjects. It will be a true representation of distribution and prevalence of atherosclerotic lesions present in the population if an autopsy study is conducted on deceased patients without any prior history of coronary artery disease and who expired due to non-cardiac causes.

## AIMS AND OBJECTIVES:

To describe the distribution of atherosclerotic plaque in coronary arteries. To ascertain the presence of luminal narrowing/occlusion of coronary arteries on gross examination. To grade the atherosclerotic lesions, microscopically according to American Heart Association grading.

## MATERIALS AND METHODS:

**Period of study:** a period of one year.
**Inclusion criteria:** All bodies subjected to medicolegal autopsy.
**Exclusion criteria:**

- Advanced stage of putrefaction
- Dismembered bodies with crush injury to chest.
- Child, infant and foetal autopsies

**Sampling and statistical methods**:
Cross sectional study involving all the cases autopsied during the period of study. Descriptive statistics like measures of central tendency, variation, proportion, percentages were calculated.

**Procedure of dissection**:
An 'I' incision is used for opening the body cavity. Chest wall dissected, rib cage opened with rib shears. Pericardium incised and the heart is held at the apex and lifted upward. With the knife held in a horizontal position, the inferior vena cava, left pulmonary vein, left pulmonary artery, right pulmonary artery, right pulmonary vein, ascending aorta, and superior vena cava are cut through in this order. The isolated heart is dissected with the enterotome. It is opened in the direction of the flow of blood.2 The opened chambers are examined. The coronary arteries are sectioned at 3-5mm intervals to assess the occlusion and wall thickening on naked eye examination. The representative sections are subjected to his to pathological examination. Lesions graded as per American Heart Association grading of atherosclerosis.

**AHA grading of coronary artery atherosclerosis:**
Grade 0: No lesion
Grade I: Isolated macrophage foam cells
Grade II: Mainly intracellular lipid accumulation
Grade III: Intracellular lipid accumulation with small extracellular lipid pools.
Grade IV: Intracellular lipid accumulation with core of extracellular core.
Grade V: Lipid core and fibrotic layer or multiple lipid cores and fibrotic layers or calcification
Grade VI: Surface defect, hematoma, hemorrhage, thrombus.

## RESULTS AND OBSERVATION:

The present study was undertaken on 445 specimens of heart collected from deceased individuals aged between 18 years to 103 years. 356 out of 445 were males and 89 females, with a male – female ratio of 4:1.
31 cases out of 445 showed only single vessel involvement in varying degrees. No cases were detected with single
vessel disease after the age of 60 in the sample analysed. Highest frequency of single vessel disease was noted in the age
group of 21-30 years with majority being males.

Table 1: Age and sex-wise distribution of single vessel disease

| Age in years | LAD | | LCA | | RCA | | LCC | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female | |
| <20 | -- | 2 | -- | -- | -- | -- | -- | -- | 2 |
| 21-30 | 3 | 3 | -- | -- | 6 | 3 | 6 | 1 | 22 |
| 31-40 | 2 | -- | -- | -- | 1 | 1 | 1 | -- | 5 |
| 41-50 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 |
| 51-60 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 |
| 61-70 | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 71-80 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 81-90 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| >90 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 5 | 5 | -- | -- | 9 | 4 | 7 | 1 | 31 |

290 out of 445 cases had triple vessel disease involving the LCA, LAD, RCA in varying degrees and in Varying combinations. The highest number of cases found in the age group of 41-50 years in males and age group of 51-60 years in females. 4 males and 1 female were found to have triple vessel disease in the age group below 20 years.

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Table 2: Age and sex-wise distribution of triple vessel disease

| Age group | No of males | No of females | Total |
|---|---|---|---|
| <20 years | 4 | 1 | 5 |
| 21-30 years | 24 | 7 | 31 |
| 31-40 years | 54 | 6 | 60 |
| 41-50 years | 65 | 13 | 78 |
| 51-60 years | 46 | 15 | 61 |
| 61-70 years | 35 | 4 | 39 |
| 71-80 years | 7 | -- | 7 |
| 81-90 years | 6 | 2 | 8 |
| >90 years | -- | 1 | 1 |
| **Total** | 241 | 49 | 290 |

88 male hearts and 14 female hearts showed grade I atherosclerotic lesions in LCA. And highest number was encountered in the age group of 31-40 years in males and 21-30 years in females. No grade I lesion detected in the age groups of 71-80 years, 81-90 years and above 90 years. 30 male heart specimen and 14 female heart specimen showed grade I atherosclerotic lesion in LAD. Highest numbers encountered in the age group of 21-30 years in both males and females. 24 out of 74 male hearts belonging to age group of 31-40 years and 5 out of 13 female hearts of age group 21-30 years showed the highest number of grade I atherosclerotic lesion in LCC. 100 hearts showed grade I atherosclerotic change in RCA and 29 male hearts belonged to the age group of 41-50 years and 8 female hearts belonged to age group of 21-30 years which were the highest number.

**Table 3: Age and sex wise distribution of grade I atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |
| Male | 2 | 26 | 36 | 19 | 4 | 1 | -- | -- | -- | 88 |
| Female | 1 | 5 | 3 | 4 | 1 | -- | -- | -- | -- | 14 |
| **LAD** | | | | | | | | | | |
| Male | 1 | 14 | 8 | 6 | 1 | -- | -- | -- | -- | 30 |
| Female | 1 | 8 | 2 | 2 | -- | 1 | -- | -- | -- | 14 |
| **LCC** | | | | | | | | | | |
| Male | 3 | 20 | 24 | 20 | 5 | 2 | -- | -- | -- | 74 |
| Female | 1 | 5 | 3 | 3 | -- | 1 | -- | -- | -- | 13 |
| **RCA** | | | | | | | | | | |
| Male | 4 | 23 | 28 | 29 | 12 | 4 | -- | -- | -- | 100 |
| Female | -- | 8 | 3 | 6 | 2 | -- | -- | -- | -- | 19 |

92 male hearts and 26 female hearts showed grade II atherosclerosis in the LCA with highest number among 41-50 years in both sexes. 112 male hearts and 22 female hearts showed grade II atherosclerosis in the LAD. 45 of male hearts belonged to age group of 31-40 years and 8 female hearts belonged to age groups 21-30 years and 41-50 years each. 89 and 18 male and female hearts respectively showed grade II atherosclerosis in the LCC with highest numbers noted in the age groups of 31-40 years and 41-50 years respectively. 81 male hearts and 28 female hearts showed grade II

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atherosclerosis in RCA with predominance in the age group of 41-50 in males and equal distribution in the age groups of
21-30, 31-40 and 51-60 in females.

**Table 4: Age and sex wise distribution of grade II atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |
| Male | 1 | 7 | 30 | 33 | 15 | 5 | -- | 1 | -- | 92 |
| Female | 6 | 3 | 5 | 6 | 5 | 1 | -- | -- | -- | 26 |
| **LAD** | | | | | | | | | | |
| Male | 4 | 29 | 45 | 29 | 4 | 1 | -- | -- | -- | 112 |
| Female | 1 | 8 | 5 | 8 | -- | -- | -- | -- | -- | 22 |
| **LCC** | | | | | | | | | | |
| Male | -- | 15 | 32 | 28 | 15 | 2 | -- | -- | -- | 89 |
| Female | -- | 2 | 6 | 8 | 2 | -- | -- | -- | -- | 18 |
| **RCA** | | | | | | | | | | |
| Male | 1 | 12 | 21 | 26 | 13 | 8 | -- | -- | -- | 81 |
| Female | 1 | 7 | 7 | 4 | 7 | 1 | -- | 1 | -- | 28 |

51-60 years in both sexes. 77 male hearts and 19 female hearts had grade III atherosclerosis in LAD with highest preponderance in the age group of 41-50 years in males and and 51-60 years in females. 55 male hearts showed grade III lesion in LCC with predominance in the age group of 41-50 years while 21 female hearts showed the same lesion with predominance in the age group if 51-60 years. 52 male hearts had grade III changes in RCA with greatest number of cases in the age group of 41-50 years while only 6 female hearts had the same lesion with equal number of cases in the age groups of 41-50 and 51-60.

**Table 5: Age and sex wise distribution of grade III atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |
| Male | -- | 2 | 7 | 18 | 22 | 7 | 1 | 1 | -- | 58 |
| Female | -- | -- | -- | -- | 7 | 1 | -- | 1 | 1 | 10 |
| **LAD** | | | | | | | | | | |
| Male | -- | 6 | 23 | 28 | 17 | 1 | -- | 2 | -- | 77 |
| Female | -- | 1 | 5 | 5 | 7 | 1 | -- | -- | -- | 19 |
| **LCC** | | | | | | | | | | |
| Male | -- | 1 | 13 | 21 | 14 | 6 | -- | -- | -- | 55 |
| Female | -- | 1 | 4 | 3 | 8 | 4 | -- | 1 | -- | 21 |
| **RCA** | | | | | | | | | | |
| Male | -- | 1 | 7 | 28 | 12 | 4 | -- | -- | -- | 52 |
| Female | -- | 1 | -- | 2 | 2 | 1 | -- | -- | -- | 6 |

31 male hearts and 12 female hearts had grade IV atherosclerotic lesion in LCA and most of the cases were in the age group of 61-70 years among males and 41-50 years among females. Grade IV lesion of LAD was found in 37 male hearts and only 7 female hearts with highest distribution of affected hearts in the age group of 51-60 years in both sexes. 31 male hearts and only 4 female hearts were affected with grade IV lesion in LCC with a majority of cases of age group 61-70 years in males and 51-60 years in females. Grade IV lesion in RCA was found in 24 male hearts and only 4 female hearts with highest numbers in the age group of 51-60 years in both sexes.

**Table 6: Age and sex wise distribution of grade IV atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |



| Male | -- | -- | 1 | 4 | 4 | 17 | 4 | 1 | -- | 31 |
|---|---|---|---|---|---|---|---|---|---|---|
| Female | -- | -- | 1 | 6 | 3 | 1 | -- | 1 | -- | 12 |
| **LAD** | | | | | | | | | | |
| Male | -- | 2 | 5 | 11 | 13 | 6 | -- | -- | -- | 37 |
| Female | -- | -- | -- | 2 | 5 | -- | -- | -- | -- | 7 |
| **LCC** | | | | | | | | | | |
| Male | -- | 1 | 2 | 5 | 9 | 12 | 1 | 1 | -- | 31 |
| Female | -- | -- | -- | 1 | 2 | 1 | -- | -- | -- | 4 |
| **RCA** | | | | | | | | | | |
| Male | -- | 1 | 2 | 5 | 8 | 7 | 1 | -- | -- | 24 |
| Female | -- | -- | -- | 1 | 2 | -- | -- | -- | 1 | 4 |

Grade V atherosclerotic lesion in LCA was noted in 15 male hearts with a predominance in the age group of 61-70 years. Similar lesion noted only in 1 female heart of age 103 years. 31 male hearts and 4 female hearts had grade V atherosclerotic lesion in the LAD with highest number of cases between ages 61-70 years among males and 51-60 years among females. 24 male hearts and 2 female hearts had grade V atherosclerotic lesion in LCC and highest number of cases noted in the age group of 61-70 years in males while both the cases were from the age group of 51-60 years in females. Grade V atherosclerotic lesion in RCA found in 23 male hearts and 4 female hearts with predominance in the age group of 61-70 years in both males and females.

**Table 7: Age and sex wise distribution of grade V atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |
| Male | -- | -- | 3 | 1 | 1 | 6 | 1 | 3 | -- | 15 |
| Female | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 |
| **LAD** | | | | | | | | | | |
| Male | -- | -- | 1 | 4 | 5 | 14 | 4 | 3 | -- | 31 |
| Female | -- | -- | -- | -- | 2 | 1 | -- | 1 | -- | 4 |
| **LCC** | | | | | | | | | | |
| Male | -- | -- | 4 | 2 | 1 | 10 | 5 | 2 | -- | 24 |
| Female | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 2 |
| **RCA** | | | | | | | | | | |
| Male | -- | -- | 3 | 1 | 2 | 9 | 4 | 4 | -- | 23 |
| Female | -- | -- | -- | -- | 1 | 2 | -- | 1 | -- | 4 |

61-70 years in a female. In contrast to LCA, grade VI atherosclerotic lesion of LAD was found in a higher number of cases, with a total of 25 cases among male hearts and 3 cases among female hearts. Highest number of cases belonged to the age group of 61-70 years in males. And equal number of cases in the age groups of 61-70, 81-90 and >90 years amongst females. LCC had grade VI atherosclerotic lesion in 18 cases in males and 3 cases in females with highest number of cases noted in the age group of 81-90 years in males and equal number of cases in age groups 51-60, 81-90 and >90 years in females. 16 male hearts and 1 female heart showed grade VI atherosclerosis in the RCA with maximum number of cases in the age group 81-90 years in males.

**Table 8: Age and sex wise distribution of grade VI atherosclerosis**

| **LCA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | <20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | >90 | Total |
| Male | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 |
| Female | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 |
| **LAD** | | | | | | | | | | |
| Male | -- | -- | 2 | 2 | 3 | 14 | 3 | 1 | -- | 25 |



| Female | -- | -- | -- | -- | -- | 1 | -- | 1 | 1 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| **LCC** | | | | | | | | | | |
| Male | -- | -- | -- | 1 | 1 | 4 | 1 | 11 | -- | 18 |
| Female | -- | -- | -- | -- | 1 | -- | -- | 1 | 1 | 3 |
| **RCA** | | | | | | | | | | |
| Male | -- | -- | -- | -- | -- | 4 | 1 | 11 | -- | 16 |
| Female | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 |

## DISCUSSION:

Cardiovascular diseases are an important cause of mortality and morbidity both in developed and developing countries. Coronary artery disease due to atherosclerosis has reached epidemic proportions in India and will soon emerge as the single largest disease accounting for deaths. Although with advancement in diagnostic modalities, the correct and complete diagnosis of cardiovascular pathology is now possible, cardiac pathology worldwide is still autopsy based. A meticulous gross autopsy examination followed by histopathological examination of the heart is still considered a gold standard in study of cardiac lesions. Till date, it is very difficult to estimate the actual prevalence of CAD due to lack of proper case reporting, prospective large epidemiological studies and absence of centralized death registry. The present study was undertaken to evaluate the presence or absence of atherosclerotic lesion and to grade the atherosclerotic lesion according to

American Heart Association. In the present study hearts with coronary atherosclerosis was noted in 413 specimens out of 445 accounting for 92.8%.

As described in the tables below, it is evident that the incidence of coronary artery atherosclerosis described by various authors; is increasing manifold with time.

**Table 9: Sex wise incidence of atherosclerosis and its comparison with other studies**

| S no | Study | Male | Female |
|---|---|---|---|
| 1. | Bhargava et.al[3] | 74.8% | 24.2% |
| 2. | Singh H et.al[4] | 68% | 27% |
| 3. | Shiladari et.al[5] | 72% | 28% |
| 4. | Garg et.al[6] | 80.9% | 19.1% |
| 5. | Prabhu M H et.al[7] | 72.72% | 27.27% |
| 6. | Dhruva G A et.al[8] | 73.6% | 26.4% |
| 7. | Present study | 81.2% | 18.8% |

**Table 10: comparison of incidence of vessel wise atherosclerosis in various studies**

| S no | Study | Incidence in LAD | Incidence in RCA | Incidence in LCA |
|---|---|---|---|---|
| 1. | Bheelwal D et.al[9] | 60.9% | 30.4% | 47.4% |
| 2. | Sudha et.al[10] | 47% | 40% | 38.1% |
| 3. | Nasrin A Q et.al[11] | 76.53% | 76.53% | 42.85% |
| 4. | Garg M et.al[6] | 38.1% | 32% | 30% |
| 5. | Dhruva et.al[8] | 42% | 32% | 30% |
| 6. | Present study | 85.6% | 78.7% | 78.4% |

**Table 11: comparision of single vessel and triple vessel disease of LAD, LCA and RCA in various studies**

| S no | Study | Single vessel disease | Triple vessel disease. |
|---|---|---|---|
| 1. | Mumtaz et.al[12] | 15.15% | 27.55% |
| 2. | Nasrin A Q et.al[11] | 36.8% | 27.55% |
| 3. | Bheelwal D et.al[9] | 21.8% | 42.3% |
| 4. | Bansal Y S et.al[13] | 86.8% | 40% |
| 5. | Porwal V et.al[14] | 15% | 42.3% |
| 6. | Dhruva et.al[8] | 17% | 36% |

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**Table 12: Comparison of commonest atherosclerotic lesion in various studies**

| S no | Study | Commonest grade of atherosclerosis | Percentage |
|---|---|---|---|
| 1. | Porwal V et.al[14] | Grade III | 40.7% |
| 2. | Bheelwal D et.al[9] | Grade III | 20.5% |
| 3. | Dhruva et.al[8] | Grade IV | 27.4% |
| 4. | Garg M et.al[6] | Grade III | 30.9% |
| 5. | Present study | Grade II | 22.8% |

## CONCLUSION:

Cross sectional study of 445 hearts dissected during medico-legal autopsy was done to look for atherosclerotic changes in four coronary vessels ie LCA, LAD, LCC and RCA. Period of study was for a period of one year. Age groups studied ranged from 18 years to 103 years. Male:female ratio was 4:1 in the present study. Only 32/445 hearts did not show atherosclerotic changes accounting for 7.2% of total cases. And 92.8% of cases showed atherosclerotic changes of varying degrees in various vessels. 31/445 hearts showed single vessel involvement accounting for 7.0% of total cases. 290/445 hearts showed triple vessel involvement constituting 65.2% of total cases. LAD was the most commonly affected coronary artery comprising of 381 cases constituting 85.6% of LADs

studied. LCC was second most frequently affected coronary vessel with 354 cases amounting to79.6% of LCCs studied. 350 out of 445 RCAs and 349 out of 445 LCAs studied showed atherosclerotic changes amounting to 78.7% and 78.4% respectively. Most common age group affected was 21-30 years amounting to 103/445 cases ie 23.1% of all cases followed closely by the age group of 31-40 years at 102/445 cases ie 22.9% and 41-50 years at 100/445 cases amounting to 22.5% of total cases. Grade I and II lesions were not detected in any of the vessels beyond age 70 years whereas only grade I and II lesions were noted in age group below 20 years. Grade V and VI lesions were not detected below thirty years of age in the present study. To conclude, The increased amount of atherosclerosis (advanced and intermediate lesions) found in the young population in this study gives an indication that antiatherogenic preventive measures need to be implemented in young individuals, so as to prevent coronary artery disease from causing premature death. And we also concur with the conclusion of Kurtis LK, 'Studying the prevalence of sub-clinical atherosclerosis in a population helps the health administrators to plan preventive measures and possible measures for reversal of atherosclerosis.15

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