

Prevalence and Correlation of Atherosclerosis in Internal Mammary Artery and Coronaries: An Autopsy Study

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ABSTRACT

Background: Coronary Artery Bypass Grafting (CABG) is one of the standard surgical procedures for treatment of multivessel Coronary Artery Disease (CAD). Among the various arterial grafts, Internal Mammary Artery (IMA) has been preferred as conduit of choice to bypass the coronary occlusion. But now with the incremental utilization of IMA grafts in CABG, there is a need for reassessment of its histological structure and presence of atherosclerosis. A prospective study was taken up to assess and correlate the prevalence of atherosclerosis in IMA and coronaries on autopsy.

Methods: Representative segments of bilateral IMA and all major coronaries were taken from 150 autopsy cases conducted at Victoria hospital, Bangalore. These were processed conventionally. H&E sections of all cases were studied microscopically for presence of atherosclerosis. Morphological assessment of atherosclerotic lesions was done according to American Heart Association (AHA) classification.

Results: Study included 114 males and 36 females. Atherosclerosis in IMA was seen in 11 (7.3 %) cases and coronary atherosclerosis in 122 (81.3%) cases. Prevalence of Coronary Atherosclerosis in male cases was 85.9%, while in female cases was 66.6%. LAD was the most commonly involved among coronaries. All 11 cases with IMA atherosclerosis showed coronary atherosclerosis. Higher AHA types of atherosclerosis (type 4/5) were not seen in IMA. There was no other vascular pathology apart from atherosclerosis in IMA.

Conclusion: The Prevalence of atherosclerosis in IMA is on a higher side suggesting a need to look for and evaluate other conduit vessels as alternate to IMA in CABG.

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Introduction

Coronary Artery Disease (CAD) is a leading cause of morbidity and mortality worldwide, commonly caused due to obstruction of coronary arteries by atheromatous plaque.⁽¹⁾

CAD is epidemic in India and one of the major causes of disease-burden and deaths. Analysis of cross-sectional CAD epidemiological studies performed over the past 50 years reveals that this condition is increasing in both urban and rural areas.⁽²⁾

The World Health Organization (WHO) has drawn attention to the fact that CAD is our modern “epidemic”, a disease which affects populations and is not an unavoidable attribute of aging. The pattern of CAD in India is perplexing as it appears a decade earlier compared with the age incidence in developed countries.⁽³⁾

Coronary Artery Bypass Grafting (CABG) is one of the standard surgical procedures for treatment of multivessel CAD. Arterial conduits are now being more frequently used as choices in place of saphenous vein grafts to achieve total arterial revascularization of the myocardium due to superior patency and long-term survival results. Among the various arterial grafts, Internal Mammary Artery (IMA) has been preferred as conduit of choice to bypass the coronary occlusion.⁽⁴⁾

IMA is an elastic artery with a thin intima and a well-formed internal elastic lamina. The primary consideration that led to the gradual transition of use of IMA as the conduit of choice is its relative freedom from atherosclerosis. Since during the last decade the frequency of coronary revascularization procedures has increased considerably and alternatives to this arterial conduit have been sought.⁽⁵⁾

Autopsy plays an important role in assessing the pathologic atherosclerotic changes. An autopsy study gives a good measure prevalence, grading and distribution pattern of atherosclerotic lesions.

Several studies have reported prevalence of atherosclerosis in coronary arteries and IMAs separately, but so far only limited studies have compared the prevalence in both vessels of the same individual. Also now with the incremental utilization of IMA grafts in CABG, there is a need for reassessment of its histological structure and presence of atherosclerosis. Hence this autopsy study was carried out to estimate the prevalence of atherosclerosis in IMA and coronary arteries and to compare both among specimens of same cadaver.

Materials And Methods

The study was carried out at Department of Pathology, Bangalore Medical College and Research Institute,

Bangalore on 150 autopsy cases of both sexes with the age group 30-60 years, having history of deaths due to natural as well as unnatural causes (accidental, suicidal, homicidal, etc.). Collection of cases was done from Department of Forensic Medicine and associated Mortuary in Victoria hospital, Bangalore.

Representative segments of IMA from both sides were removed from the selected autopsy case. The heart was dissected by inflow-outflow method⁽⁶⁾ at autopsy. For each side of the heart, the atrium is opened first, and then the ventricle is opened along its inflow and outflow tracts, following the direction of blood flow.

Left Anterior Descending Artery (LAD), Left Circumflex Artery (LCX) and Right Coronary Artery (RCA) were dissected longitudinally until they entered the musculature. The coronary arteries were cut in cross sections at 3–5 mm intervals and examined grossly for presence of any atherosclerosis, thrombus and narrowing. If found, a representative bit was taken while in absence of any lesion, a random section was taken from each coronary artery. Heavily calcified vessels were removed and decalcified prior to sectioning.

The collected specimens (segments of IMAs and Coronaries) were fixed in 10% formalin solution for 2-5 days and later processed conventionally by embedding in paraffin blocks. After blocking specimen in paraffin, 4 to 5 micron slide sections were prepared, stained with Haematoxylin and Eosin (H & E) method according to standard procedures.

Histological evaluation of each slide was performed using a light microscope (Olympus BX51) equipped with polarization filters.

Both IMAs and all three major coronaries were examined for presence of any atherosclerotic lesions. The typing of atherosclerotic lesions was done according to the criteria^(7,8) suggested by the American Heart Association (AHA) which is based on morphological descriptions.

The classification consists of 6 different numeric categories to include

- a. Early lesions of initial type I and type II (fatty streak);
- b. Intermediate lesions of type III (transitional); and
- c. Advanced plaques characterized as type IV (atheroma); type V (fibroatheroma or atheroma with thick fibrous cap); and type VI (complicated plaques with surface defects, and/or hematoma-hemorrhage, and/or thrombosis).

Type V is further subdivided as :

- Va (Fibroatheroma)
- Vb (Calcified plaque)
- Vc (Fibrous plaque)

All IMAs were assessed for intactness of Internal Elastic Lamina (IEL). The IMAs were also looked for the presence of any other vascular pathology apart from atherosclerosis.

Descriptive data were presented as numbers and percentages. Discrete variables were compared using the Chi-square test (χ^2). A p-value of 0.05 or less was considered for statistical significance.

Result

The present study was carried out on 150 autopsy cases of both sexes with the age group 30-60 years. The study included 114 (76%) males and 36 (24%) females. Majority were in the age group of 30-40 years (54%) followed by 41-50 years (32%) and 51-60 years (14%) respectively. (Table 1)

Both Left and Right IMAs were studied in all 150 cases. There were no histological differences between the IMAs of both sides. The thick IEL was appreciated in all segments and also there were no discontinuities, even in those segments which had atherosclerotic lesions. The Intima

was very thin in all segments that had normal histology. The Mean Medial thickness for LIMA (Left Internal Mammary Artery) was 223.7 μm with range of 141 – 317 μm , while for RIMA (Right Internal Mammary Artery) was 219.3 μm with range of 158 – 296 μm .

7.3% (11/150) cases showed atherosclerotic lesions with mean age of 48.7 years. The 11 cases included 10 males and 1 female. All these 11 cases with IMA atherosclerosis had coronary atherosclerosis (Table 2). IMA atherosclerosis was majorly observed in the age group of 41-50 years (46%) followed by 51-60 years (36%) (Table 4).

Most common type of atherosclerotic lesion observed was AHA type 1 for both LIMA and RIMA. Only one segment (LIMA) showed type 3 lesion. None of the IMAs showed type 4 / type 5 lesion. All cases with IMA atherosclerosis showed bilateral involvement except one case of unilateral involvement (LIMA). There was no other vascular pathology apart from atherosclerosis in IMA.

Coronary atherosclerosis was present in 122 cases (81.3%) with mean age of 43 years. Prevalence of atherosclerosis in male cases was 85.9%, while in female cases was 66.6%. LAD was the most commonly (74%) involved coronary artery followed by LCX (68%) and RCA (60%) respectively. AHA type 2 atherosclerotic change was the most common type of atherosclerotic lesion seen in both

Table 1: Showing Age-wise Distribution of cases (n=150)

Sl. No.	Age (years)	No. of cases	Percentage (%)
1	30-40	81	54
2	41-50	48	32
3	51-60	21	14
	Total	150	100

TABLE 2: Showing correlation of Coronary atherosclerosis in cases with IMA Atherosclerosis (n=11)

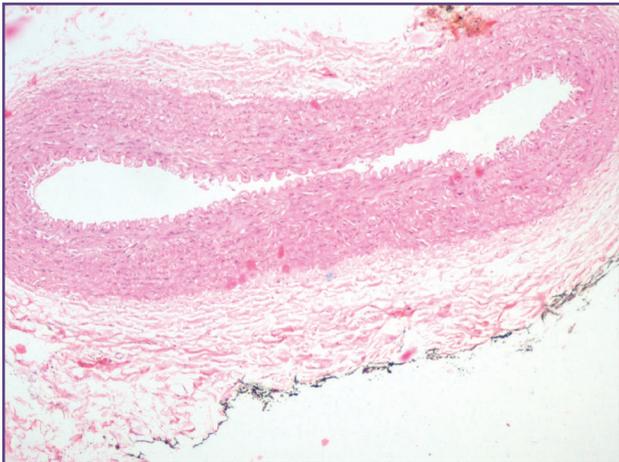
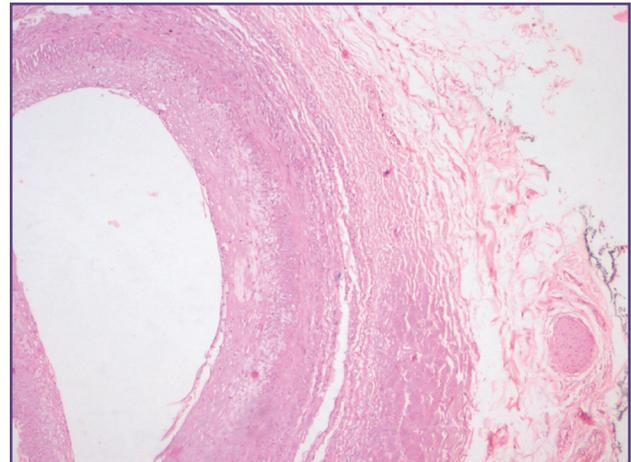
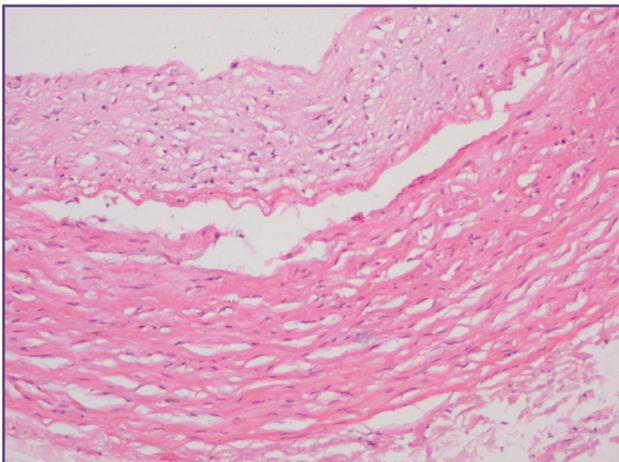
SI. No.	Case No.	Age	Sex	Atherosclerosis type (AHA)				
				LIMA	RIMA	LAD	LCX	RCA
1	26	60	M	2	1	5b	2	3
2	63	55	M	3	1	5b	5b	4
3	69	57	M	1	1	2	2	1
4	71	50	M	1	1	5b	0	0
5	89	32	M	1	1	3	2	0
6	101	50	M	2	1	5a	3	1
7	107	45	F	2	2	4	3	2
8	115	60	M	1	0	1	0	2
9	116	50	M	1	1	4	3	1
10	124	42	M	1	1	5b	5b	5b
11	149	35	M	2	2	2	2	0

Table 3: Showing Prevalence rate of Atherosclerosis in IMA among various studies

SI. No.	Study	Year	No. of Cases	Prevalence rate (%)
1	Present Study	2013	150	7.3
2	Puri N et al,	2010	100	6
3	HJ Sons et al,	1993	117	6.6
4	Singh RN et al,	1983	150	2
5	Kay et al,	1976	215	4.2

TABLE 4: Showing IMA Atherosclerosis association in different age groups (n=11)

Sl. No.	Age group (years)	No. of Cases	Percentage (%)
1	30 - 40	2	18
2	41 - 50	5	46
3	51 - 60	4	36

**Fig. 1: Photomicrograph of Internal Mammary Artery showing normal histology (H & E, 100x)****Fig 3: Photomicrograph of Internal Mammary Artery showing foam cell aggregates and extracellular lipid pools in intima : AHA Type 3 atherosclerosis (H & E, 100x)****Fig 2: Photomicrograph of Internal Mammary Artery showing foam cell aggregates in intima : AHA Type 2 atherosclerosis (H & E, 200x)**

LAD and LCX while in RCA, AHA type 1 atherosclerotic change was the most common.

Discussion

Atherosclerosis is a chronic immunoinflammatory, fibro-proliferative disease of large and medium-sized arteries fuelled by lipid.⁽⁹⁾ Autopsy is a tool of real value for assessment of pathologies, which are difficult to assess in the living. As study of atherosclerosis in the living

population is difficult, invasive and expensive, especially in developing countries, autopsy studies have been proved to be a good method for assessing atherosclerosis.⁽¹⁰⁾

In the present study, no significant difference was noted in the IMAs of both sides in terms of Mean Medial thickness which was 223.7 Vs 219.3 μm (LIMA Vs RIMA). Even in a study by Kinoshita et al,⁽¹¹⁾ no significant difference was found between the two in the width of media (149 vs 148 μm). Kneubil et al,⁽¹²⁾ in a sequential histomorphometric study on LIMA found that tunica media thickness ranged between 185.5 \pm 60.1 to 219.4 \pm 71.2 μm .

Histological assessment on paired segments of 150 IMAs in our study confirm the intactness of the thick IEL and prevalent elastic component in tunica media of IMAs. Even in all IMAs with atherosclerotic involvement, the IEL was intact.

Atherosclerosis in IMA was present in 7.3% and coronary atherosclerosis in 81.3% cases of our study, while in a similar study by Puri N et al, on 100 cadavers found IMA atherosclerosis in 6% and coronary atherosclerosis in 86% of all cases.⁽¹³⁾

In an angiographic study on 117 patients by Sons HJ et al, 58.1% had CAD and evidence of atherosclerotic change in IMA was present in 6.6% patients,⁽¹⁴⁾ while an

arteriographic study on 150 patients with CAD by Singh RN et al, reported presence of atherosclerosis of IMAs in 2%.⁽¹⁵⁾ In an autopsy study by Kay et al, IMA atherosclerosis was present in 4.2%.⁽¹⁶⁾

The prevalence of atherosclerosis in IMA is comparatively higher in our study as depicted in Table 3.

In present study, all cases with atherosclerotic lesions in IMAs showed bilateral involvement except one case of unilateral involvement (LIMA). Even in an autopsy study by Markl et al,⁽¹⁷⁾ the occurrence rates of atherosclerosis were equal for IMAs of both sides, while in the study by Puri et al,⁽¹³⁾ atherosclerosis in IMA was unilateral.

Most common type of atherosclerotic lesion observed in IMA was AHA type 1. Even in study by Puri et al,⁽¹³⁾ only type 1 and type 2 changes were seen. All cases of IMA atherosclerosis had associated coronary atherosclerosis which is in concordance with similar observations by Sons HJ et al,⁽¹⁴⁾ and Puri et al.⁽¹³⁾

Atherosclerotic changes were much more marked in the coronary artery than in the IMA ($P < 0.05$, statistically significant) which was also observed in other studies by Puri et al,⁽¹³⁾ and Julke et al.⁽¹⁸⁾

Despite a low incidence of atherosclerosis in the IMA, a late closure rate of 10% has been identified after 10 to 15 years.⁽¹⁹⁾ Huddleston et al, identified certain factors that influence IMA patency and they were such as the existence of competitive flow by the native coronary bed, the quantity of coronary bed, the presence of lateral branches causing flow 'steal', dyslipidemia, diabetes mellitus, systemic arterial hypertension, progression of the atherosclerotic disease and technical problems during surgery.⁽²⁰⁾

Sims^(19, 21) pointed out that the IEL has a key role in arterial wall structure. His observations suggest that the occurrence of discontinuities in the IEL provokes early and progressive intimal hyperplasia. Also Sims^(21, 22) in a comparative histological study between the muscular coronary artery and the primarily elastic IMA suggested that the number of discontinuities in the IEL and the degree of intimal thickening were significantly greater in the coronary artery. Even suggested that gaps in the IEL allow Smooth Muscle Cells of the media to proliferate into the intima.

Atherosclerosis in Coronaries is markedly higher than in IMAs because IMA is an elastic artery and coronaries are muscular arteries. In the IMAs, intimal hyperplasia develops at a considerably delayed rate because proliferative smooth muscle cells are present only to a moderate extent. In addition, the multiple elastic lamellae and the thick IEL form barriers to their invasion.⁽⁵⁾ Thus the IMA has a low incidence of atherosclerosis in comparison to the coronary arteries but is not free from atherosclerotic

involvement. Judged by the relative patency rates that are emerging for alternative arterial grafts,^(23, 24) it seems likely that whatever protects the IMA from atherosclerosis in situ or as a graft may be shared to some extent by arteries such as the radial, gastroepiploic, and inferior epigastric arteries. Thus comparison studies of evaluating the predilection sites of atherosclerosis with that of the protected areas in the vascular tree are required.

Conclusion

The Prevalence of atherosclerosis in IMA is on a higher side in our study. All cases with IMA atherosclerosis had associated coronary atherosclerosis. No other vascular pathology, apart from atherosclerosis was seen in IMA.

The present study findings on IMAs disprove the statement of IMA being free from atherosclerosis and concludes that IMA has a low but consistent incidence of atherosclerotic involvement. The present study suggests a need to look for and evaluate other conduit vessels as alternate to IMA in CABG.

Future research on larger samples is suggested to confirm the findings of our study. It is proposed to study the clinical correlates and also associated risk factors of atherosclerosis.

Abbreviations and Symbols

CAD	Coronary Artery Disease
CABG	Coronary Artery Bypass Grafting
AHA	American Heart Association
H & E	Hematoxylin and Eosin
IMA	Internal Mammary Artery
IHD	Ischemic Heart Disease
IEL	Internal Elastic Lamina
LIMA	Left Internal Mammary Artery
LCX	Left Circumflex Artery
LAD	Left Anterior Descending Artery
RIMA	Right Internal Mammary Artery
RCA	Right Coronary Artery
WHO	World Health Organisation

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Declarations

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Competing Interests

None declared

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