

Determinants of Risk Factors Associated with Aortic Atherosclerosis: A Quantitative Study in Forensic Autopsies

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<https://dx.doi.org/10.13005/bbra/3211>

(Received: 19 January 2024; accepted: 29 February 2024)

Cardiovascular diseases have become a major burden in the whole world and the top of it is atherosclerosis causing deaths. It is characterized as the thickening of the arterial walls with the fatty material which includes cholesterol, cellular wastes, and fibrin. The atherosclerosis can be hereditary, due to aging, any autoimmune disease causing inflammation of endothelial or because of the sedentary lifestyle. Atherosclerosis is a consequence of dysfunction of endothelial done by low-density lipoprotein and changes in it by the internal wall of arteries. Smoking increases the oxidation stress and decreases the accessibility of nitric oxide to the endothelial wall which leads to vasodilatory response. These changes are irreversible. Pre-mature aging also contributes to the destruction of the epithelial wall of arteries eventually leading to hypertension, which if left untreated can cause atherosclerosis. This is a cross-sectional study conducted for a period of one year and the sample size of 110 was taken of which 65.5% were male and the rest were females. This study includes all those patients' bodies who can go through autopsy and excludes patients whose bodies are mutilated or decomposed or those patients' bodies whose history is not properly available. Consents were taken from the relatives of the victims. The autopsy was done after the proper identification and examination of the patient's body. The thoracic cavity was cut and opened. The aorta was cut from its origin to the diaphragm. The operational criterion was determined by grading from 1 to 5 based on the severity and thickness of aortic atherosclerosis. The data was statistically analyzed by applying the student's t-test. The significant value of $p < 0.01$ was considered. Mostly males were affected. Out of 110 deceased more than 50% were from rural areas. 58% of the population have grade 1 and grade 2 atheromatous plaques. Most affected males were in the age of 50 years to 59 years and females were most affected in 60 years to 69 years in their lifetime. This study also reveals that out of 110 dead bodies 64 patients died due to cardiac issues the rest died due to non-cardiac causes. The study also tells about the direct relation of atherosclerosis with hypertension, hyperlipidemia, hyperglycemia, and smoking habits with a significance level of $p < 0.001$. The present study shows that it is more common in males than females and victims belonged to the age group of 5th to 8th decade. This reveals that aging is the dominating factor of residence. Rural people have it more than urban due to lack of awareness and diagnostic facilities Also a direct correlation between atherosclerosis and hypertension, hyperlipidemia, hyperglycemia, and smoking has been seen and confirmed through statistical significant.

Keywords: Aortic Atherosclerosis; Hyperglycemia; Hypertension; Plaque.

Atherosclerosis is a vast topic for research. Cardiovascular diseases have become a major burden in the whole world and the top of it is

atherosclerosis causing deaths¹. It is characterized by the thickening of the arterial walls with the fatty material which includes cholesterol, cellular

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wastes, and fibrin². It usually involves the aorta at a priority than the rest of the arteries. If this happens in the thoracic aorta then the possibility of involvement of coronary and carotid system increases³.

Atherosclerosis is a consequence of the dysfunction of endothelial done by low-density lipoprotein (LDL) and changes in it by the internal wall of arteries⁴. These LDLs along with other atherogenic factors initiate the endothelial cells for the healing process, which leads to the addition of monocytes to the walls of arteries. LDLs are detected by differentiated monocytes and vascular smooth muscles, in return promoting the formation of foam cells⁵. This causes some other inflammatory processes to trigger⁶. The turbulent flow of the vascular material can cause disruption leading to the dysfunction of endothelial⁷. When endothelial cells are unable to maintain homeostasis, the walls of vessels start to constrict⁸. Mainly, this induces an inflammatory process which is the first step in the formation of atheromatous plaque⁹.

Hemodynamic forces play a major role in the destruction of endothelial walls¹⁰. The turbulent flow of blood creates a temporal and spatial pitch, which increases the oscillatory index and decreases the shear stress¹¹. This helps lipoprotein to get inside the intima due to disturbed endothelial integrity¹². Another ingredient that causes the endothelial to become dysfunctional is nitric oxide. L-arginine produces nitric oxide in endothelial cells, which diffuses across the cell membrane and reaches the artery walls and tissues. It normally promotes the relaxation of smooth muscle called endothelium-dependent vasodilation¹³. Nitric oxide mainly protects the smooth vessels from atherogenesis but hypertension, hyperlipidemia, smoking, and hyperglycemia all decrease the production of Nitric oxide¹⁴.

Once LDLs are inside the intima, they start to oxidize by free radicals such as hydroxyl ions, due to the absence of protective plasma antioxidants¹⁵. This induces the activation of the endothelial wall. This activation then results in a complicated inflammatory response which initiates with the increased production of NF-kB. NF-kB helps in the secretion of leucocytes, chemokines, and prothrombotic molecules¹⁶. After the activation of endothelial, monocytes start to roll and are captured by endothelial.

This leads to the adhesion of monocytes to the arterial walls of vessels. Once inside the layers, monocytes are seen as macrophages which are pro-inflammatory molecules, in response to an inflammatory environment change into anti-inflammatory molecules¹⁷. This initiates a majority of reactions in the endothelial wall, which causes an efflux system between anti-inflammatory and pro-inflammatory causing a foam cell formation. This is how atherosclerosis is formed and later on changes into fibrous plaque because of the necrotic core. A necrotic core is an area where the majority of lipid-rich cells and other free cells are present¹⁸. For the stability of this plaque, fibers cover the necrotic core, hence formatting a fibrous cap¹⁹. The fibrous cap is a barrier that separates vessels and atherosclerosis to prevent thrombosis reaction to the necrotic core²⁰.

Smoking is becoming a new trend in the young generation. It is one of the many causes of coronary heart disease. Many studies have shown the harmful effects of both active and passive smoking. There are many reasons related to the mechanism of damage due to smoking which are not clear but one of the major causes is the dysfunction of endothelial due to smoking. Smoking increases the oxidation stress and decreases the accessibility of nitric oxide to the endothelial wall which leads to vasodilatory response and these changes are irreversible²¹. Aging is the normal process of the body but aging can have a negative effect on the walls of arteries, for example, aging vessels show an increase in collagen deposition which dilates the vessel and increases the size of the lumen²². This increases the glycated protein which is an age-associated increase along with it meta-2-proteinase enzyme and angiotensin-2-signaling increases which leads to the impairment of elasticity of vessel and therefore causes vascular stiffness²³ and eventually causes hypertension. High blood pressure damages the endothelial cells²⁴.

METHODOLOGY

Examination of atherosclerosis is not possible in a living person because of its invasive nature and can be costly. Therefore the existence of an autopsy-based study is extremely useful for a better understanding of atherosclerosis. This study was conducted for a period of one year and the

sample size of 110 was taken of which 72 (65.5%) were male and the rest were females 38 (34.5%). This study includes all those patients' bodies who can go through autopsy and excludes patients whose bodies are mutilated or decomposed or those patients' bodies whose history is not properly available. This study has gone through a Cross-sectional descriptive study. The patients' bodies were assigned for autopsy after the consent from their relatives and also after the legal work was done according to government rules and laws. The autopsy was done after the proper identification and examination of the patient's body. The thoracic cavity was cut and opened. After that, the lungs were laid open. The aorta is cut from its origin to the diaphragm, where there is an opening of the aorta. After this aorta is dissected to the renal arteries followed by division of the diaphragm. The aorta which has been dissected is again cut from its posterior surface and the presences of athermanous plaque were observed and noted, if present, and grading was assigned according to operational definition. The data was statistically analyzed by applying the student's t-test. The significant value of $p < 0.01$ was considered.

The operational criterion was determined by grading the severity and thickness of aortic atherosclerosis. Less than 2mm thickness of aortic atherosclerosis was considered normal with grade 1. Mild was graded when atherosclerosis was 2-3mm thick which is also named as mild/focal or diffuse thickness is grade 2. Grade 3 which has an Atheroma, thickness of more than 3-5mm with no ulceration or movement of components was considered moderate. Grade 4 includes Atheroma which has a thickness of more than 5mm with no

mobile or ulcerated component and was graded as severe. Grade 5 included Grade 2,3, or 4 atheroma which has mobile and ulcerated components.

RESULTS

Out of 110 victims, 85 (77%) who reported for autopsy had atherosclerosis. Out of these 85 patients, 55 were males and 30 were females.

According to Table 1 most affected males were in the age of 50 years to 59 years and females were most affected in 60 years to 69 years in their lifetime. Out of 110 deceased more than 50% were from rural areas and the rest were from urban residences.

Table 2 shows that hyperlipidemia dominates in atherosclerosis as compared to other variables. Other studies also show LDL deposition can initiate an inflammatory response, which can lead to hypertension. The study done by WHO shows only hypertension cannot have a severe impact on atherosclerosis²⁵.

Table 1. Age distribution and gender

Years	Male	Female
>80y	0	2
70-79y	3	3
60y-69y	13	20
50y-59y	30	8
40y-49y	13	4
30y-39y	10	1
20y-29y	3	0
10y-19y	0	0

Table 2. Distribution based on hypertension, hyperlipidemia, hyperglycemia, and smoking

Variables	Hypertension	Hyperlipidemia	Hyperglycemia	Smoking
Present	46 (41.8%)	75 68.1%	37 (33.6%)	33 (30%)
Absent	64 (58.1%)	35 (31.8%)	73 66.4%	77 (70%)

Table 3. Correlation of grading atherosclerosis with hypertension, hyperlipidemia, hyperglycemia, and smoking

Variables	Correlation	Hypertension	Hyperlipidemia	Hyperglycemia	Smoking
Grading	Sig.(2-tailed)	<0.001	<0.001	<0.001	<0.001

Table 4. Distribution according to Grading of aortic atherosclerosis

Grade	Frequency/Percentage
1	33 (30%)
2	31 (28%)
3	23 (21%)
4	17 (15%)
5	6 (6%)

Table 3 shows the direct relation of atherosclerosis with hypertension, hyperlipidemia, hyperglycemia, and smoking habits with a significance level of $p < 0.001$ in all instances.

Table 4 reveals that 58% of the population have grade 1 and grade 2 atheromatous plaque. This study also reveals that out of 110 dead bodies 64 patients died due to cardiac issues the rest died due to non-cardiac causes.

DISCUSSION

Atherosclerosis is characterized as a systemic inflammatory disease that starts from the branching points of the arteries. The earliest site of atherosclerotic disease is the abdominal aorta. This is because the hemodynamic plays an important role in locating atherosclerosis. Atherosclerosis is more common and causes deaths in developing countries than in developed countries¹.

The present study shows a prevalence of atherosclerosis of about 77% which is much higher than the studies done by Dhruva et al which show a 23.3% prevalence²⁶, and Garge et al whose study represents 46.4% of incidence²⁷. This study reveals that atherosclerosis has a direct relation with age. It is more common between the 5th to 6th decades. These results were similar to the results by DeBakey et al. that age is one of the risk factors for this disease²⁸. Hence, we can conclude that it is a part of the aging-related illness. It is also related to the premature aging²⁹.

This study also showed interest in the location of the victims to know how atherosclerosis affects according to residence. Urban areas have atherosclerosis less than rural because of the more awareness and fewer or restricted diagnostic facilities in rural areas. Yet geographically it is still

unexplained properly as genetics and environmental factors contribute a lot. Nevertheless, hypertension and hyperglycemia are exacerbating factors more prevalent among urban dwellers, yet they are cognizant of these issues and have access to superior medical facilities³⁰. Aortic atherosclerosis can lead to other problems like hypertension, atrial fibrillation, carotid artery disease, diabetes, and stroke³¹. Nevertheless, our study reveals that is not a risk factor for stroke but it is just a sign of aging. The problems arise when aging causes high blood pressure which remains untreated, so it results in the building of plaque in the arteries³². The reason for this is high pressure of blood can damage the artery wall which results in the formation of plaque which adds to more narrowing of arteries. This narrowed artery cuts or leans the blood flow to heart muscles, hence depleting the heart of oxygen. Concerning this our study has also shown a direct relation of aortic atherosclerosis with hypertension with p value < 0.001 .

In addition, our study also considers that smoking also adds up to the formation of atherosclerosis as smoking plays an important role in the cause and progression of cardiovascular diseases. Smoking leads to atherogenesis initiation by damaging the endothelial layer which causes a reduction of high-density lipoproteins, producing an increase in oxidized proatherogenic lipids which is clearly shown in this study³³. Similarly, hyperglycemia and hyperlipidemia also contribute to cardiovascular and cerebrovascular diseases³⁴. Similar to this study, Chaudhary along with others has shown that hyperlipidemia can lead to the progression of atherosclerosis³⁵. It states that an injury to the endothelial wall of arteries can start a healing process which can lead to atherosclerosis. A chemical agent called homocysteine can aggravate this process leading to the formation of atherosclerosis³⁶.

In addition to what has already been mentioned diabetes mellitus also has a direct relation with atherosclerosis. Diabetes type 1 and 2 can increase the rate of development of atherosclerosis. The pathological process includes an increase in glucose levels, inflammation, and oxidative stress. To protect such patients, glucose levels should be controlled and the other risk factors should also be reduced.

CONCLUSION

Atherosclerosis is a vast topic for study yet our study reveals only socio-demographic profiles and correlation with other leading factors of victim. The present study shows that it is more common in males than females and victims belonged to the age group of 5th to 6th decade. This reveals that aging is the dominating factor, Premature aging can also cause atherosclerosis. Rural people have it more than urban due to lack of awareness and diagnostic facilities. Also a direct correlation between atherosclerosis and hypertension, hyperlipidemia, hyperglycemia, and smoking has been seen and confirmed as being statistically significant.

ACKNOWLEDGEMENT

The author would like to thank the hospital administration for conduction of this study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Funding Sources

This research received no external funding

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