Original Article

Is Being Tall Cardioprotective? Correlation Between Height And Atherosclerosis. An Autopsy Study

Thej MJ, Kalyani R, Kiran J [1]

Department of Pathology and Forensic Medicine, [1]

Sri Devaraj Urs Medical College, Kolar, Karnataka

ABSTRACT

Objectives: *Ischemic heart disease (IHD) following atherosclerosis is the most common cause of cardiac deaths worldwide. Short stature has been said to be associated with an increased risk of coronary heart diease (CHD) in many Western populations but contradictory reports have emerged from Asian studies and a few Western studies. Degree of atherosclerosis being an indicator of future IHD, its association with height of the subjects was assessed in the present study.*

Materials and Methods: *Hearts and aortas from 120 autopsies, 82 male and 38 female were assessed. Most patients had died of non-vascualar causes except for two who died of myocardial infarction. Height was measured to the nearest 0.5 cms using flexible measuring tape. Atherosclerosis was microscopically assessed using the modified American Heart Association classification based on morphological descriptions. The results were statistically analyzed using the SPSS software for Windows version 16 using Pearson's Chi-square.*

Results: *The degree of atherosclerosis of the coronaries and aortas of short and tall males and only coronaries of short and tall females showed that the difference was not statistically significant ($p > 0.05$). However the difference in degree of atherosclerosis of aorta of tall and short females was statistically significant ($p = 0.02$).*

Conclusion: *These data refute the hypothesis that stature is inversely related to risk of CHD. The hypothesis that short stature is an adverse risk factor for CHD has been studied mainly in the Western populations and it does not seem to hold true in the present study done in a rural South Indian population of Kolar. Further prospective follow up studies and autopsy studies are required to confirm and apply these findings to the Indian scenario.*

Keyword: *Atherosclerosis, height, autopsy*

Corresponding Author:

Dr. Kalyani. R

Prof. of Pathology

Sri Devaraj Urs Medical College,

Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar-563101 Karnataka

Mobile: 9448402775

Email: drkalyanir@rediffmail.com

INTRODUCTION

Cardiovascular disease (CVD) has emerged as a major health burden worldwide with atherosclerosis being the major cause.[1] For several decades, investigators have put enormous efforts to determine a link between body habitus and risk for cardiovascular disease. A number of case-control and cohort studies from Britain, Europe and from North America

have reported an increased risk of coronary heart disease (CHD) in shorter individuals.[2,3,4,5,6,7,8,9] In the past 20 years, the "bigger is better" misconception has been promoted by studies that found that taller people had lower death rates from heart disease and all causes than shorter people.[10] In contrast, many studies like the Framingham Heart Study, the first National Health and Nutrition Examination Survey.[11] found no relation between height and heart disease when age and years of education were adjusted.[10,12,13] Prospective studies done in Asian countries like Japan and South Korea have also found no relation between height and CVD.[14,15,16]

Ischemic heart disease (IHD) following atherosclerosis is the most common cause of cardiac deaths worldwide.[17] Atherosclerosis affects the Indian population at a younger age than in other ethnic groups with more severe and extensive angiographic involvement, leading to increased morbidity and mortality.[18] Given the limited ability, invasiveness and high cost of current clinical imaging methods to visualize the vessel wall, we are highly dependent on autopsy material for describing various different stages of atherosclerosis.[19] Studying the prevalence of sub-clinical atherosclerosis in a population helps the health administrators to plan measures which help in prevention and possible reversal of atherosclerosis.[20] In addition, the relationship of body habitus like height with relation to degree of atherosclerosis can also be studied.

In this autopsy based study of atherosclerosis in the population of Kolar, Karnataka, we set out to study the relationship between height of the subjects and the degree of atherosclerosis.

MATERIALS AND METHODS

The study was conducted on the hearts and aortas obtained from medicolegal autopsies conducted by the department of forensic medicine at Kolar, a district with mostly rural population located in the southern part of Karnataka. The height in centimeters (cms) of the subjects was measured accurately using flexible measuring tapes to the nearest 0.5cms. The hearts and aortas were fixed in 10% buffered formalin. The heart was dissected along the flow of blood, left anterior descending, left circumflex and right coronary arteries were dissected longitudinally until they entered the musculature. The coronaries were examined for the presence of thrombus, narrowing and atherosclerosis. Aorta was cut along its posterior surface and examined for atherosclerosis. Bits were taken from both coronaries and aorta from gross atherosclerotic lesions as well as suspicious lesions for microscopic assessment of the atherosclerosis. Microscopic grading of atherosclerosis was done using the modified American Heart Association (AHA) Classification of atherosclerosis based on morphological descriptions.[19] This specific classification was used since it offers better categorization of atherosclerotic lesions based on morphological descriptions compared to the earlier AHA classification which was too rigid with its descriptions of lesions using Roman numericals and was not useful in subdividing the intermediate lesions of atherosclerosis. According to this classification the non-atherosclerotic intimal lesions are intimal

thickening and intimal xanthoma which differ based on the amount of foam cells in the intima. The progressive atherosclerotic lesions are pathological intimal thickening ± erosion, fibrous cap atheroma ± erosion, plaque rupture, calcified nodule and fibro calcific plaque. The modified AHA classification describes thick and thin fibrous cap atheromas with the thin cap atheroma carrying higher chances of rupture and thrombosis with consequent obstruction of blood flow in the coronaries causing IHD.

The study material comprised of 120 hearts and aortas from 82 males and 38 females. Most subjects had died of non-vascular causes except for 2 subjects who suffered a sudden death due to myocardial infarction. 55 subjects died due to suicidal poisoning, 59 due to road traffic accidents, 2 due to snake bite, 1 from alcohol intoxication and 1 from ruptured uterus. The age of the subjects ranged from 8 to 85 years.

The height cut off for defining tall and short males and females was taken from the average mean height of males and females in the state of Karnataka from the National Family Health Survey -3, 2005-2006. [21,22] which was 166 cms for males and 153 cms for females. All males above 166cms were considered as tall and below 166cms as short. All females above 153 cms were considered as tall and below 153 cms as short.

The degree of atherosclerotic lesions in coronaries and aorta was statistically analysed between the tall males and short males and between tall females and short females. The SPSS software for Windows Version 16 was used and Pearson's Chi-square test was used to statistically assess for significance of the findings.

RESULTS

In the male group, 36 were short and 46 were tall. The average height of all the males was 166.62 ± 5.6 cms, which correlates well with the NFHS -3 data for average height of males in Karnataka. The average age of the short males was 37.75 ± 15.5 yrs. The heights of short males ranged from 152 to 165 cms with a mean of 161.83 ± 3.42 cms. The average age of the tall males was 36.54 ± 12.42 yrs. The heights of tall males ranged from 167 to 185 cms with a mean of 170.34 ± 3.09 cms.

Among the females, 17 were short and 21 were tall. The average height of all the females was 156.52 ± 9.74 cms, which is around 3 cms more than the NFHS -3 data of average height for females in Karnataka. The average age of the short females was 29.29 ± 20.27 yrs. The heights of short females ranged from 122 to 152 cms with a mean of 148.58 ± 8.35 cms. The average age of the tall females was 40.66 ± 16.64 yrs. The height of short females ranged from 155 to 175 cms with a mean of 162.95 ± 4.79 cms.

In the coronary arteries of the 36 short males, 17 showed non-atherogenic lesions, 8 showed intermediate lesions (mainly pathological thickening) and 11 showed fibrous cap atheromas [Table 1]. In the coronaries of the 46 tall males, 13 showed non-atherogenic lesions, 20 showed intermediate lesions and 20 showed fibrous cap atheromas [Table 2]. The difference observed between the tall and short males was not statistically significant (p= 0.206). In the aorta of the 36 short males, 3 showed non-atherogenic lesions, 21 showed

Table 1: Shows degree of atherosclerotic lesions in coronaries & aortas in short males.

Short Males	Coronaries	Aorta
Non-atheromatous	47%	8%
Pathological intimal thickening	22%	50%
Advanced atherosclerotic lesions	31%	42%

Table 2: Shows degree of atherosclerotic lesions in coronaries & aortas in tall males.

Tall Males	Coronaries	Aorta
Non-atheromatous	28%	8%
Pathological intimal thickening	44%	46%
Advanced atherosclerotic lesions	28%	46%

Table 3: shows degree of atherosclerotic lesions in coronaries & aortas in short females.

Short Females	Coronaries	Aorta
Non-atheromatous	41%	29%
Pathological intimal thickening	35%	47%
Advanced atherosclerotic lesions	24%	24%

Table 4: shows degree of atherosclerotic lesions in coronaries & aortas in tall females.

Tall Females	Coronaries	Aorta
Non-atheromatous	33%	0%
Pathological intimal thickening	38%	52%
Advanced atherosclerotic lesions	29%	48%

intermediate lesions and 12 showed fibrous cap atheromas [Table 1]. In the aorta of the 46 tall males, 4 showed non-atherogenic lesions, 21 showed intermediate lesions and 21 showed fibrous cap atheromas [Table 2]. The difference observed between the tall and short males was not statistically significant (p= 0.497).

In the coronary arteries of the 17 short females, 8 showed non-atherogenic lesions, 6 showed intermediate lesions and 3 showed fibrous cap atheromas [Table 3]. In the coronaries of the 21 tall females, 7 showed non-atherogenic lesions, 8 showed intermediate lesions and 6 showed fibrous cap atheromas [Table 4]. The difference observed between the tall and short females was not statistically significant (p= 0.624). In the aorta of the 17 short females, 5 showed non-atherogenic lesions, 8 showed intermediate lesions and 4 showed fibrous cap atheromas [Table 3]. In the aorta of the 21 tall females, showed no non-atherogenic lesions, 11 showed intermediate lesions and 10 showed fibrous cap atheromas [Table 4]. The difference observed in aortic atherosclerosis between the tall and short females was statistically significant (p= 0.021) with tall females having higher degree of atherosclerosis in the aorta.

DISCUSSION

For several decades, considerable effort has been put into identifying precursors of coronary heart disease.[13] In addition to the traditional cardiovascular risk factors, several studies have examined the contribution of body habitus to the risk for mobidity and mortality due to CVD. [13] An inverse association between stature and CHD was first reported by Gertker et al in 1951.[2] Since then many number of Western studies have observed such an association.[2,3,4,5,6,7,8,9] Many studies have also contradicted such an association both in taller Western population and in the relatively shorter Asian population.[10,12,13,14,15,16]

Height is an easily measured variable, and is determined by genetic predisposition, nutrition, physical and social environments, as well as other factors that play a role during childhood and adolescence.[16]

The studies implicating short stature as a risk factor for CHD reason out that low socioeconomic background with associated risk factors such as poor nutrition and infections resulting in poor fetal or early-life growth result in short stature and also are associated with increased atherosclerosis.[4,23] According to Barker's Hypothesis of Fetal origin of adult diseases, poor fetal growth has been said to cause permanent metabolic changes which lead to impaired response to insulin, higher systolic blood pressure in adulthood and these changes are frontrunners in causing atherosclerosis.[24] However, the hypothesis of early origins of CHD remains controversial and the biological mechanisms behind the associations are still unclear. [8] Some authors have suggested that shorter men are more prone to develop CHD because they have smaller coronary arteries, a feature that bears an influence on blood pressure.[4,8] Few studies blame the catch-up growth during the first years of life among children who are born small which leads to greater fat accumulation and resulting

in atherosclerotic precursors which in adulthood progress to full blown complicated atherosclerosis.[23]

In contrast, Samaras et al state that most of these studies implicating short stature as a risk factor for CHD have involved a relatively small number of deceased people and results may have been confounded by socioeconomic and other factors.[12,23] Gupta R et al have reported that the prevalence of CHD and hypertension was substantially higher in taller Hindus compared to shorter Muslims in an Indian study.[25] Reports from China also refute the link between short stature and CHD and according to their data, CHD mortality was positively correlated with increasing height.[26] During the second half of the 20th century, the people living the longest included the Japanese, Hong Kong Chinese and Greeks all being shorter and weighing less than northern Europeans and North Americans.[10] A study done by Hameed K et al in Pakistan reported that compared to a short cohort, affluent males were 2 cms taller and females 4 cms taller with the taller affluent population having a relative risk for IHD 3 times that of the shorter cohort.[27]

A report on a 25- year study of Okinawans living in an island off mainland Japan, have the greatest longevity in the world and they are shorter and weighed less than mainland Japanese.[10] The Okinawans have the maximum number of centanarians among whom males average 148.3 cms and females, 138.6 cms.[10]

Data from animal studies found that larger animals within the same species have rapid growth, higher reproductive effort and accelerated aging with which they develop chronic diseases which are age related, majorly cardiovascular disease.[10]

The hypotesis suggested by studies who refute a link between short stature and CHD risk are aplenty. Abundant protein and calories lead to taller height, fatter and heavier bodies which leads to obesity which is one of the major causes for increased atherosclerosis and CHD.[10,12] A number of risk factors like higher left ventricular mass (LVM), left ventricular hypertrophy (LVH), increased blood pressure are associated with taller height and are risk factors for atherosclerosis and CHD.[12,28]

It is well known that in all populations, women have a lower incidence of coronary heart disease compared to men although women are shorter, thus indicating that although height plays a role, its not an independent risk factor for CVD risk.[23] The average height before the 20th century was about 10cms shorter than today, yet, CHD before 1900 was rare.[10] Since the 1960's, countries like India and Singapore have seen a rapid increase in the incidence of CHD although the trends in stature has been a linear increase in height.[10,23] These data suggest that other risk factors play a more important role than height per se.

In the present study, the correlation of the degree of atherosclerosis in coronaries and aorta between short and tall males and between coronaries in short and tall females was not significant, indicating that short stature in this population does not seem to be a major risk factor for the development of atherosclerosis. The positive correlation seen in the atherosclerosis of aorta in females is consistent with findings of Framingham study.[13] The

statistically significant findings obtained when degree of atherosclerosis in aorta of short females and tall females were compared can be due to the fact that the mean age of short females (29.29 ± 20.27 yrs) was significantly lesser than that of the taller females(40.66 ± 16.64 yrs).

The conflict in findings of the present study with other studies can be explained by the fact that height is only a part of the total CVD picture.[10,12] Other risk factors can overwhelm the influence of height on CVD mortality. The higher CVD mortality found in several studies of shorter people in Western countries is puzzling and possible explainations include socioeconomic status, maternal and childhood malnutrition and childhood diseases all of these factors causing linear growth restriction.[10,12,13,23]

Limitations of this study was that as weight of the subjects was not available, correlation of atherosclerosis with body mass index could not be done. The history regarding cardiovascular risk factors and socioeconomic status of the subjects was not available.

Strength of the study includes the application of the modified AHA classification of atherosclerosis which can delineate the intermediate lesions which carry higher risk of progression to complicated atherosclerosis better than the earlier AHA classification. This modified classification has rarely been applied in the Indian scenario. Studying the degree of atherosclerosis gives a clear picture of the CHD risk in future. The subjects were of different age groups which add value to the results since atherosclerosis is an age dependant phenomenon.

CONCLUSION

The "bigger is better" misconception has been promoted by studies that found taller men to have lower death rates from heart disease. Virtually all these studies have ignored abundant data showing that short height per se does not adversely affect health.[10,12]

Women, the Japanese, the Chinese and most short populations experience much less CHD than taller populations in Western countries.[12] Although the effect of short stature on development of atherosclerosis cannot be completely ruled out, it appears that in the presently studied population other CHD risk factors like socioeconomic conditions, poor diet habits, smoking and bad childhood nutrition to name a few, have a more profound effect. The search for non-traditional risk factors for CHD will always go on and such risk factors need to be studied and validated in each population since risk of atherosclerosis differs between populations and also inside a single homogenous population.

REFERNCES

1) Mohan V, Deepa R. Risk factors for Coronary Artery Disease in Indians. JAPI 2004;52:95-97.

2) Parker DR, Lapane KL, Lasater TM, Carleton RA. Short stature and cardiovascular disease among men and women from two southeastern New England communities. Int J of Epidemiol 1998;27:970-975.

3) Lawlor DA, Taylor M, Smith GD, Gunnel D, Ebrahim S. Associations of components of adult height with coronaery heart disease in postmenopausal women: the Bristish women's heart and health study. Heart 2004;90:745-749.

4) Paajanen TA, Oksala NKJ, Kuukasjarvi P, Karhunen PJ. Short stature is associated with coronary heart disease: a systematic review of the literature and a meta-analysis. Eur Heart J 2010; 31(14): 1802-1809.

5) Wamala SP, Mittleman MA, Horsten M, Schenck-Gustafsson K, Orth-Gomer K. Short stature and prognosis of coronary heart disease in women. Journal of Internal Medicine 1999;245:557-563.

6) Hebert PR, Rich-Edwards JW, Manson JE, Ridker PM, Cook NR, O'Connor GT et al. Height and incidence of cardiovascular disease in male physicians. Circulation 1993;88:1437-1443.

7) Wannamethee GS, Shaper AG, Wincup PH, Walker M. Adult Height, Stroke and Coronary Heart Disease. Am J Epidemiol 1998;148:1069-1076.

8) Kee F, Nicaud V, Tiret L, Evans A, O'Rielly D, Backer GD. Short Stature and Heart Disease: Nature or Nurture? Int J Epidemiol 1997;26:748-756.

9) ForsenT, Eriksson J, Qiao Q, Tervahauta M, Nissinen A, Tuomilehto J. Short stature and coronary heart disease: a 35-year follow up of the Finnish cohorts of The Seven Countries Study. Journal of Internal Medicine 2000;248:326-332.

10) Samaras TT. Height, body size and longevity: is smaller better for the human body? West J Med 2002;176:206-208.

11) Liao Y, McGee DL, Cao G, Cooper RS. Short stature and risk of mortality and cardiovascular disease: Negative findings from the NHANES I Epidemiologic Follow-up Study. J Am Coll Cardiol 1996;27:678-82.

12) Samaras TT, Elrick H, Storms LH. Is short height really a risk factor for coronary heart disease and stroke mortality? A review. Med Sci Monit 2004;10(4):63-76.

13) Kannam JP, Levy D, Larson M, Wilson PW. Short stature and risk for mortality and cardiovascular disease events. The Framingham Heart Study. Circulation 1994; 90: 2241-2247.

14) Song YM, Sung J. Adult Height and the Risk of Mortality in South Korean Women. Am J Epidemiol 2008;168:497-505.

15) Song Y, Smith GD, Sung J. Adult Height and Cause-specific Moratlity: A Large Prospective Study of South Korean Men. Am J Epidemiol 2003;158:479-485.

16) Honjo K, Iso H, Inoue M, Tsugane S. Adult height and risk of cardiovascular disease among middle aged men and women in Japan. Eur J epidemiol 2011;26:13-21.

17) Yazdi SAT, Rezaei A, Azari JB, Hejazi A, Shakeri MT, Shahri MK. Prevalence of atherosclerotic plaques in autopsy cases with non-cardiac death. Iranian Journal of Pathology 2009;4(3):101-104.

18) 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; 26:243-246.

19) Virmani R, Kolodgie FD, Burke AP, Farb A, Schwartz SM. Lessons From Sudden Coronary Death: A Comprehensive Morphological Classification Scheme for Atherosclerotic Lesions. Arterioscler Thromb Vasc Biol 2000;20:1262-1275.

20) Curtiss LK. Reversing Atherosclerosis? N Engl J Med 2009;360(11):1144-1146.

dissection. The right RLN was not found as expected. We then traced the vagus nerve superiorly. At the level of the isthmus, a type 1B NRLN (Fig. 1) was seen coursing horizontally from cervical trunk of vagus nerve. The left RLN had a normal course. Vocal cord functions were normal after surgery. Postoperative MRA showed a right aberrant subclavian artery, having a direct origin from anteromedial aortic arch and running retroesophageal (Figs 2A and B).

DISCUSSION

Brief History

A NRLN on the right side was first described by Stedman in 1823. In 1935, Berlin reported this anomaly on the left side.[2]

Incidence

Frequency of occurrence is variable, it is around 0.5 to 0.7%[1] in thyroid surgeries which may differ in general population.

Embryology

RLN is the nerve of the 6th branchial arch, with the descent of the heart the nerve passes beneath the 6th aortic arch and then ascends to the larynx. On the right side, distal portion of the 6th and 5th aortic arch disappears and the nerve moves beneath the 4th aortic arch which becomes the future subclavian artery. Occasionally, the 4th arch disappears and the subclavian arises directly from the aorta (aberrant subcalvian artery) in such cases the nerve moves cranially and originates directly from the vagus, on the left side, it is usually associated with situs inversus or a right aortic arch.[3]

Three types of NRLN have been described as follows:

- *Type IA:* The nerve has a straight course at the level of superior thyroid pedicle.
- *Type IB:* (Most common) the nerve runs transversely at the level of isthmus.
- *Type II:* Nerve has a downward course and loops upwards before reaching trachea esophageal groove.[1]

Diagnosis

The surgical importance of a NRLN is its vulnerability during thyroid surgery, no reliable symptoms and signs indicate the possibility of NRLN. An aberrant subclavian artery is almost always associated with NRLN, hence demonstration of such vascular anomaly by CT scan, MR angiography or digital subtraction angiography would be important to suspect a NRLN or even rarely, if the patient has complaints of dysphagia (dysphagia lusoria). In most of the cases reported, these tests were used retrospectively.[1]

The RLN has several anatomical variations, hence identification and complete exposure of RLN is considered the safest approach for thyroid and parathyroid surgeries by most authors.[4]

We at our institution have developed the practice of opening the fascia between the carotid artery and thyroid gland using blunt dissection, with the exception of middle thyroid vein, all structures coursing transversely are preserved till the RLN is identified low down in the neck, which is then traced superiorly. Using this operative technique, we were able to identify a right NRLN in one such case.

CONCLUSION

Recurrent laryngeal nerve has several anatomical variations. Nonrecurrent laryngeal nerve is a rare anomaly, overlooking it can be catastrophic. A sound anatomical knowledge and systematic dissection of the RLN will help us to preserve its function during thyroid and parathyroid surgeries.

REFERENCES

1. Abboud Bassam, Aouad Rony. Nonrecurrent inferior laryngeal nerve in thyroid surgery: Report of three cases and review of the literature. The Journal of Laryngology and Otology 2004; 118:139-42.
2. Page C, Monet P, Peltier J, Bonnaire B, Strunski V. Non-recurrent laryngeal nerve related to thyroid surgery: Report of three cases. The Journal of Laryngology and Otology 2008; 122:757-61.
3. Nagayama Ikuo, Okabe Yozo, Katoh Hideaki, Furukawa Mitsuru. Importance of preoperative recognition of the non-recurrent laryngeal nerve. The Journal of Laryngology and Otology 1994;108:417-19.
4. Raffaeli Marco, Iacobone Maurizio, Francios Jean. The false non-recurrent inferior laryngeal nerve. Surgery 2000;128:1082-87.

ABOUT THE AUTHORS

Sagaya Raj (Corresponding Author)

Assistant Professor, Department of ENT, Sri Devaraj URS Medical College, Kolar, Karnataka, India, e-mail: sagayaraj79@gmail.com

Ravi Padmakar Deo

Professor, Department of ENT, Sri Devaraj URS Medical College Kolar, Karnataka, India

Azeem Mohiyuddin

Professor, Department of ENT, Sri Devaraj URS Medical College Kolar, Karnataka, India

Shuaib Merchant

Fellow, Department of Surgical Oncology and ENT, Sri Devaraj URS Medical College, Kolar, Karnataka, India

Manaswini Ramachandra

Postgraduate Student, Department of ENT, Sri Devaraj URS Medical College, Kolar, Karnataka, India