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Original Article

Internal Medicine Section

A Study of Correlation of Neck Circumference with Framingham Risk Score as a Predictor of Coronary Artery Disease

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ABSTRACT

Introduction: It has been observed that metabolic syndrome is risk factor for Coronary Artery Disease (CAD) and exerts its effects through fat deposition and vascular aging. CAD has been acknowledged as a leading cause of death. In earlier studies, the metabolic risk has been estimated by Framingham risk score. Recent studies have shown that Neck Circumference (NC) has a good correlation with other traditional anthropometric measurements and can be used as marker of obesity. It also correlates with Framingham risk score, which is slightly more sophisticated measure of CAD risk.

Aim: To assess the risk of CAD in a subject based on NC and to correlate the NC to Framingham risk score.

Materials and Methods: The present cross-sectional study, done at Karnataka Institute of Medical Sciences, Hubli, Karnataka, India, includes 100 subjects. The study duration was of one year from 1st January 2015 to 31st December 2015. Anthropometric indices Body Mass Index (BMI) and NC were correlated with 10 year CAD risk as calculated by Framingham risk score. The correlation between BMI, NC, vascular age and Framingham risk score was calculated using Karl Pearson's correlation method.

Results: NC has a strong correlation with 10 year CAD risk ($p \le 0.001$). NC was significantly greater in males as compared to females ($p \le 0.001$). Males had greater risk of cardiovascular disease as reflected by higher 10 year Framingham risk score ($p \le 0.0035$).

Conclusion: NC gives simple and easy prediction of CAD risk and is more reliable than traditional risk markers like BMI. NC correlates positively with 10 year Framingham risk score.

Keywords: Fat deposition, Ischemic heart disease (IHD), Risk stratification

INTRODUCTION

Ischemic Heart Disease (IHD) is the most common cause of death worldwide. CAD is responsible for 7.4 million deaths in 2012 globally [1].

In recent times, IHD mortality has increased by 20 times and it is highest in Eastern Europe and Central Asian countries. It has lowest rates in countries with high income where it has been reduced by half. Mortality rates are increasing in low and middle income countries, responsible for 80% of CAD deaths [2].

CAD has recently been acknowledged as a leading cause of death in Indian population [3]. In the year 2000, there were 29.8 million people with CAD in India that is about 3% prevalence rate [4,5]. In the year 2003, the prevalence was estimated to be 8%-10% in urban areas and 3%-4% in rural areas [6,7]. Overall prevalence of CAD in Southern India in 2003 was estimated to be 11%.

There are well defined risk factors for CAD. These include smoking, family history, obesity, hypertension, diabetes, lack of exercise, stress and hyperlipidemia [8,9].

Metabolic syndrome is considered to be an important risk factor for CAD. It exerts its effects through paracrine effects, fat deposition and vascular aging [10]. Cardiovascular risk is determined by specific fat distribution patterns, particularly upper body adiposity, which is more strongly associated with glucose intolerance, hyperinsulinemia, diabetes, and hyper-triglyceridemia than lower body obesity [11].

The detection or screening for obesity is usually done with the help of traditional anthropometric indices BMI, Waist Circumference (WC), Waist Hip Ratio (WHR). These are the major indicators of obesity, but unfortunately vary with lifestyle, diet and respiratory movements.

NC is a new anthropometric index, which has overcome the limitations of traditional anthropometric indices, has been evaluated as an index for the distribution of upper body subcutaneous adipose tissue in relation to cardiovascular risk factors [12] and insulin resistance. It can be correlated with metabolic syndrome [13]. NC can be a marker of obesity and it also has a good correlation with other anthropometric measurements. NC has independent correlation with metabolic risk factors and with other anthropometric indices of obesity [14,15].

This new anthropometric index can provide a non-invasive, patient friendly method, for prediction of CAD. NC promise to be a more reliable anthropometric index of central obesity and asymptomatic CAD and helps in prophylactic prediction of CAD in populations.

Vascular Age (VA) is a means of representing an individual's cardiovascular risk. It represents real atherosclerotic damage. Vascular aging is due to arterial wall stiffening and is mainly caused by the elastic lamellae degeneration and abnormal collagen deposition in the arterial wall [16,17]. In 2008, a new cardiovascular risk table from the Framingham heart study was published, which incorporated the new concept as age of the heart or 'vascular age'. This age is calculated as the age of a person would be with the same calculated cardiovascular risk but whose risk factors were all within normal range [18]. Framingham CAD risk score is a traditional scoring system which estimates the VA and is used to predict 10 year risk of CAD in a patient who does not have a proven disease at that time. The present study was designed to find the correlation of NC with 10 year risk of CAD and VA, as determined by Framingham CAD risk score.

MATERIALS AND METHODS

A cross-sectional study was conducted at Karnataka Institute of Medical Sciences, Hubli, over a period of one year, from 1st January 2015 to 31st December 2015. Patients were screened from Out Patient Department (OPD) and In Patient Department (IPD) and 100 patients were selected. Those who fulfilled the inclusion criteria and agreed to be the part of the study, were evaluated and investigated. Written, informed consent was taken from all of them after explaining the aims and procedure of the study. In case the patient was illiterate, the consent was completed using thumb impression in presence of witnesses.

Study Design

Patients having the following Framingham risk score criteria were screened and included into the study:

1. Age >30 years;
2. Systolic blood pressure more than 120 mmHg;
3. On antihypertensive medications;
4. Habit of smoking;
5. Presence of diabetes mellitus;
6. Total cholesterol ≥ 160 mg/dl;
7. HDL cholesterol <50 mg/dl.

Patients who had been diagnosed with coronary artery disease/ stroke or TIA/familial hyper-cholesterolemia or with kidney disease were not taken up for the study.

Anthropometric Measures

A preformed structured proforma was used to note the details of all the subjects. To assess the CAD risk factors, height, weight and NC were measured in all of the subjects. Participant's body weight was measured to the nearest 0.1 kg on an electronic device and height measurement was done using stadiometer to 0.1 cm accuracy, and subjects standing erect in Frankfort horizontal plane. BMI was calculated by formula {BMI=weight(Kg)/ height(m^2)}.

NC measurement was done at the level of laryngeal prominence using a tape to an accuracy of 0.1 cm.

Biomarkers Assessment

Fasting lipid profile, Fasting Blood Sugar (FBS) and Post Parandial Blood Sugar (PPBS) were tested in all of them using venous blood, after overnight fasting. The levels of Total Cholesterol (TC), Triglycerides (TG), High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) were determined enzymatically by using an auto-analyser.

Framingham risk score was calculated in terms of 10 year CAD risk score and VA. Correlation between NC and Framingham risk score and VA was done by statistical software.

STATISTICAL ANALYSIS

The data were analysed using software IBM–SPSS. Mean and standard deviation for each continuous variable were calculated. The correlation between NC and Framingham risk score was tested using Karl Pearson's correlation coefficient method. Significance was assessed at 5% level of significance (p<0.05).

RESULTS

The baseline characteristics of the study subjects are shown in [Table/Fig-1].

There was significant gender difference in regard to age, BMI and VA in the study. NC was significantly greater in male compared to females (p≤0.001). Also, males showed greater risk of cardiovascular disease as reflected by significantly higher 10 year Framingham risk score (p≤0.0035) when compared to females [Table/Fig-2].

There was a significant correlation of BMI with VA (p <0.0086) and 10 year Framingham risk score (p<0.0675) [Table/Fig-3].

S.No	Variables	Data
1.	**Age (years)**	
	Mean ±SD	45.39±13.61
	Range	30-74
2.	**Sex ratio (M:F)**	1.44:1
3.	**Hypertension**	26 (26%)
4.	**Diabetes mellitus**	18 (18%)
5.	**Smoking**	23 (23%)

[Table/Fig-1]: General characteristics of the patients studied.

Variables	Summary	Male	Female	Total	t-value	p-value
Age in years	Mean	47.83	41.88	45.39	2.1922	0.0307*
	SD	12.94	13.93	13.61		
BMI	Mean	21.70	21.45	21.60	0.3154	0.7532
	SD	3.80	4.02	3.88		
Neck circumference	Mean	34.30	32.15	33.42	4.4554	≤0.001*
	SD	2.60	2.00	2.59		
10 year risk score	Mean	13.30	6.68	10.59	2.9904	0.0035*
	SD	11.99	9.06	11.32		
Vascular age	Mean	54.27	46.15	50.94	1.7439	0.0843
	SD	21.04	25.39	23.15		

[Table/Fig-2]: Comparison of male and females with mean age, BMI, NC, 10 year CAD risk score and vascular age.
* Significant

Variables	Correlation (BMI)		
	r-value	t-value	p-value
Vascular Age	0.2613	2.6795	0.0086*
10 year Framingham risk scores	0.1836	1.8489	0.0675

[Table/Fig-3]: Correlation between BMI and vascular age, Framingham risk scores by Karl Pearson's correlation coefficient method.
* Significant

Variables	Correlation (NC)		
	r-value	t-value	p-value
Vascular age	0.4334	4.7611	≤0.001*
10 year Framingham risk scores	0.4196	4.5762	≤0.001*

[Table/Fig-4]: Correlation between NC and vascular age, Framingham risk scores by Karl Pearson's correlation coefficient method.

There is significant correlation of NC with VA (p≤0.001) and 10 year Framingham risk scores (p≤0.001) [Table/Fig-4].

DISCUSSION

The third report of National Cholesterol Education Program (NCEP) in 2005 highlighted the importance of treating patients with the metabolic syndrome to prevent cardiovascular diseases [I9]. The International Diabetes Federation (IDF) updated their metabolic syndrome criteria in 2006 and using WC, fasting glucose, BP, triglycerides and HDL-cholesterol as it's elements [20].

Regional variation in adipose tissue in lower body and upper body peripheral fat distribution, visceral fat and fatty liver has been correlated well with cardiovascular disease risk [21]. BMI, WC and WHR are conventionally used as markers of obesity and are correlated with metabolic syndrome [22-24]. Even though NC has been used to measure body fat, it has not been tested as a marker for Cardiovascular disease mortality [11]. WHR/WC measurements are easily affected by meals, breathing, and clothing. NC is not affected by these parameters. In the present study, we have used NC along with other anthropometric indicators of Cardiovascular disease risk assessment and studied its correlation with Framingham's risk score. Preis SR et al., assessed the association between increase in NC and CAD risk factors in 3307 participants and concluded that NC was positively correlated with CAD risk even after adjustment for BMI and visceral adipose tissue [15].

In the present study, as we found out that NC has a positive correlation with CAD risk score and also observed that NC was significantly greater in males as compared to females ($p<0.001$). Correspondingly, males had greater risk of cardiovascular disease reflected by higher 10 year Framingham's risk score ($p\leq0.0035$), as in [Table/Fig-2]. A possible explanation for this phenomenon is that visceral adipose tissue lipolysis accounts for an increasing proportion of hepatic free fatty acids delivery. As the visceral fat increases, the CAD risk increases [25].

High BMI has been associated with higher overall mortality [26]. BMI has been demonstrated to have a suboptimal correlation with body fat, especially in patients with Cardiovascular disease [27] and high BMI subjects were also found to contribute to lower mortality in those with Cardiovascular disease [28]. In the present study, there was no significant correlation between BMI and 10 year risk score ($p\leq0.0675$), as shown in [Table/Fig-3]. Compared to BMI, the NC had better correlation with both VA and 10 year CAD risk ($p\leq0.001$), as in [Table/Fig-4]. The study shows evidence in support of this obesity paradox and is consistent with other studies [29]. So, NC is a superior predictor of CAD risk as compared with BMI. NC is not influenced by these paradoxes and showed stronger correlation to predict CAD morbidity. Dai Y et al., conducted a prospective cohort study on 12,151 high-risk patients having two or more Cardiovascular disease risk factors from 2004 to 2014 and showed that higher NC indicated a higher incidence of future Cardiovascular disease events and all-cause mortality in both male and female [11].

BMI is used as a marker of insulin resistance and overweight. Abdominal obesity confers a still higher metabolic risk to an individual [30]. Visceral adipose tissue is a better anthropometric predictor of metabolic risk factors than BMI [31]. Visceral adiposity, independent of BMI, is a substantial marker of VA in patients with Type-2 diabetes [32]. It has been observed that in comparison to chronological age, VA correlates with Framingham risk score and arterial stiffness [16]. In the present study, BMI had statistically significant correlation with VA ($p<0.0086$), as shown in [Table/Fig-3]. However, NC has a better correlation with vascular age ($p<0.001$) than BMI, as shown in [Table/Fig-4]. Hence, NC correlates better with VA and visceral adiposity as compared to BMI.

LIMITATION

Sample size is smaller; hence the generalization of the results is difficult. Additionally, NC is only an indirect marker of visceral adiposity and hence CAD risk. Direct measurement of visceral adiposity can make the role of NC in CAD risk stratification clearer.

CONCLUSION

From this study, we can conclude that NC is a strong predictor of CAD risk and is more reliable than traditional risk markers like BMI. NC correlates positively with 10 year Framingham risk score seems to be a simple measure of cardiac risk stratification and it can be used as a tool to take prophylactic measures for achieving secondary prevention.

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