Comparison between the Waist-Hip Ratio and BMI in Assessing the Severity of Coronary Artery Disease

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ABSTRACT

BACKGROUND

According to large studies like Framingham survey, anthropometric measurements are an important measurement for risk assessment of cardiometabolic disease. The correlation between anthropometric measurement and coronary artery disease (CAD) has been controversial in various studies conducted previously. Thus, to determine a better tool among WHR and BMI for assessing the severity of CAD the study was conducted among CAD patients**.** Also to compare the relationship between WHR and BMI in assessing severity of coronary artery disease and to correlate other independent risk factors in severity of CAD**.**

METHODS

The study included 103 patients presenting as acute coronary syndrome (ACS). All patients were subjected to past medical history, clinical examination including anthropometric assessments, laboratory investigations and coronary angiography was performed. They were grouped into significant CAD and insignificant CAD patients based on the luminal stenosis.

RESULTS

Among the 103 patients in the study, males and females were 80 (77.66 %) and 23 (22.33 %) respectively. In the study 91 (88.34 %) patients had CAD and 12 (11.65 %) patients had insignificant CAD. In the study most of the patients had STEMI 70 (68 %), followed by NSTEMI in 22 (21.4 %) and unstable angina in 11 (10.6 %). Among the CAD patients most of them had SVD 52 (50.5 %), then followed by DVD in 28 (27.2 %) and TVD in 11 (10.7 %). In the study, according to Spearman's rho correlation there was significant positive correlation between number of vessels affected and waist hip ratio. There was no significant correlation between BMI and number of vessels involved.

CONCLUSIONS

There was significant correlation between the WHR and severity of CAD compared to BMI and CAD. The study also showed positive correlation with the lipoprotein-a levels and severity of CAD.

KEY WORDS

Waist Hip Ratio, Body Mass Index, Coronary Artery Disease.

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BACKGROUND

Cardiovascular disease is one of the leading causes of disease burden in the world with leading mortality and morbidity. There is nearly doubling of the prevalence of the disease in the past three decades, with increased number of younger age group being affected.[1]

According to different epidemiological studies, several cardiovascular risk factors which are nonmodifiable and modifiable have been identified. Some of the nonmodifiable risk factors are advanced age, family history, and male gender, whereas modifiable risk factors include hypertension, diabetes, obesity, physical inactivity, dyslipidaemia, unhealthy diets, smoking, and heavy alcohol intake.[2]

Obesity is one of the emerging health problems and its incidence is increasing in developing countries because of the westernization of diet and lifestyle. It is one of the important risk factors for cardiovascular diseases as well as for other systemic illness. Central fat distribution is thought to be more atherogenic than a peripheral fat distribution, hence approaches for clinically evaluating central obesity have been studied. The clinical examination of obesity can be done using some of the clinical methods like waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), and body mass index (BMI).[3]

Objectives

To find out the correlation of WHR and BMI in patients with acute coronary syndrome and to assess the severity of coronary artery disease in respect to individual parameters.

METHODS

This is an observational study conducted in Karnataka Institute of Medical Sciences, Hubli. The study was conducted after the Ethical Committee of the Institute approval. The study included 103 patients who presented with acute coronary syndrome. Study subjects were assessed for demographic and risk factors like the age, sex, history of diabetes, hypertension and family history of CAD in the first-degree relatives of the subjects. The sample size was calculated for omnibus one-way ANOVA using G*Power software version 3.1.5. From the results of previous study and considering loss to follow up non response final sample size is 103 patients.

Inclusion Criteria

Patients who presented with acute coronary syndrome and who were willing for the study by giving written consent.

Exclusion Criteria

1. Infections and inflammatory disorders,
2. Patients on lipid-lowering drugs
3. Chronic liver dysfunction,
4. Women on oral contraceptives or hormone replacement therapy,
5. Acute or chronic renal dysfunction, and
6. Patients on steroids.

Patients were examined while wearing an examination gown. Each measurement was carried out twice, with the average being used in the analysis. For height and weight, we utilised the nearest 0.1 units of measurement. The height of the patients was measured with a tape metre in standing position with the shoulders in a normal alignment. Weight was measured using digital electronic weighing scale and rounded to the nearest 100g. BMI is expressed in kg per m^2 based on corresponding units, i.e., weight divided by square root of height. The hip circumference is taken at the widest area of the hips at the greatest protuberance of the buttocks, while the waist circumference is taken at midway between the lowest rib and iliac crest.

Waist circumference is considered increased in males and females if it is > 102 cms and >88 cms respectively. WHR is calculated by dividing the waist circumference by the hip circumference. A ratio of > 0.9 in males and > 0.8 in women is considered to be abnormal and obese. Blood samples were collected early morning after an overnight fast and immediately centrifuged and stored at -70ºC and assessed according to the following methods: Serum creatinine by modified Jaffe's, triglycerides by glycerol phosphate oxidase (GPO) method, total cholesterol by cholesterol oxidase phenol 4-aminoantipyrine peroxidase (CHOD-PAP) method, LDL-C by precipitation method involving polyvinyl sulfonic acid (PVS) and polyethylene- glycol methyl ether (PEGME) complex, and lipoprotein-a by immunoturbidimetry method. According to ATP III criteria for the diagnosis of metabolic syndrome it considers dyslipidaemia, if triglycerides >150 mg/dl, HDL < 40 mg/dl, LDL-C > 100 mg/dl, fasting blood glucose ≥ 110 mg/dl, waist circumference >102 cm in males and >88 cm in females,[4] additionally in this study the total cholesterol > 200 mg/dl and lipoprotein-a >30 mg/dl is considered abnormal.

The study subjects who fulfilled the criteria, underwent coronary angiogram. Based on the coronary angiogram study subjects were divided into subjects with significant CAD and insignificant CAD (no vessel involved / normal coronaries). Significant CAD was defined by > 50 % luminal stenosis of one of the major vessels (i.e., left anterior descending, circumflex, or right coronary artery) or its branches and insignificant CAD includes luminal stenosis of < 50% of the major vessels or its branches. Significant CAD is assessed for the severity in the form of number of vessels affected like single, double or triple vessel involvement which was represented as SVD, DVD and TVD respectively.

Statistical Analysis

Data was entered into Microsoft Excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Spearman's correlation was done to find the correlation between two quantitative qualitative variables.
Graphical representation of data: MS Excel and MS Word was used to obtain various types of graphs such as bar diagram, Pie diagram and Scatter plots. p value (probability that the result is true) of < 0.05 was considered as statistically significant after assuming all the rules of statistical tests. [5,6,7]

RESULTS

Among the 103 patients in the study, male and female were 80 (77.66 %) and 23 (22.33 %) respectively. In the study, 91 (88.34 %) patients had CAD and 12 (11.65 %) patients had insignificant CAD. In the study most of the patients had STEMI 70 (68 %), NSTEMI in 22 (21.4 %) and unstable angina in 11 (10.6 %). In the CAD patients most of them had SVD 52 (50.5 %), then followed by DVD in 28 (27.2 %) and TVD in 11 (10.7 %). From the study, it is found that 74 (71.80 %) patients had LAD vessel involvement, LCX vessel involvement in 34 (33.0 %) and RCA vessel involvement in 33 (32.0 %). In males the age group of 41-60 years were affected more in number while among females age group of 61-80 years were significantly affected. Regarding the cardiovascular risk factors assessed like diabetes, hypertension and family history in both CAD and insignificant CAD patients, it was present in 29,35,15 and 4,6,2 subjects respectively. Based on anthropometric measurement assessed it was found that 18 subjects had BMI > 25kg/m^2, 8 subjects had increased waist circumference and 44 subjects had increased WHR among CAD patients from Table 1, 2 and 3.

		N	%
Type of ACS	NSTEMI	22	21.4%
	STEMI	70	68%
	Unstable angina	11	10.6%
No. of vessels	Insignificant CAD	12	11.7%
	SVD	52	50.5%
	DVD	28	27.2%
	TVD	11	10.7%
LAD	Yes	74	71.8%
	No	29	28.2%
LCX	Yes	34	33.0%
	No	69	67.0%
RCA	Yes	33	32.0%
	No	70	68.0%

Table 1. Presentation and Extent of Coronary Artery Disease

NSTEMI- Non-ST elevation myocardial infarction, STEMI – ST elevation myocardial infarction, ALWMI – anterolateral wall MI, ASWMI – anteroseptal wall MI, IWMI – inferior wall MI, LAD – left anterior descending artery, LCX – left circumflex artery, RCA – right coronary artery.

		Number of Vessels								P value
		Insignificant CAD		Coronary Artery Disease SVD		DVD		TVD		
		N	%	N	%	N	%	N	%	
Male age	21 to 40 years	2	22.2%	7	77.8%	0	0.0%	0	0.0%	0.094
	41 to 60 years	5	10.0%	28	56.0%	10	20.0%	7	14.0%	
	61 to 80 years	1	4.8%	8	38.1%	9	42.9%	3	14.3%	
Female age	21 to 40 years	1	16.7%	2	33.3%	3	50.0%	0	0.0%	0.456
	41 to 60 years	3	33.3%	3	33.3%	2	22.2%	1	11.1%	
	61 to 80 years	0	0.0%	4	50.0%	4	50.0%	0	0.0%	

Table 2. Distribution of Age with Number of Vessels Involved

		Number of Vessels								P value
		Insignificant Coronaries		Coronary Artery Disease SVD		DVD		TVD		
		N	%	N	%	N	%	N	%	
Sex	Male	8	10.0%	43	53.8%	19	23.8%	10	12.5%	0.235
	Female	4	17.4%	9	39.1%	9	39.1%	1	4.3%	
History of HTN	Male	4	14.8%	11	40.7%	6	22.2%	6	22.2%	0.148
	Female	2	13.3%	5	33.3%	7	46.7%	1	6.7%	0.585
History of DM	Male	3	11.5%	14	53.8%	4	15.4%	5	19.2%	0.454
	Female	1	14.3%	2	28.6%	4	57.1%	0	0.0%	0.656
Family history of CAD	Male	1	7.1%	7	50.0%	3	21.4%	3	21.4%	0.728
	Female	1	33.3%	0	0.0%	2	66.7%	0	0.0%	0.445
Raised cholesterol (≥200 mg/dl)	Male	0	0.0%	4	57.1%	2	28.6%	1	14.3%	0.831
	Female	0	0.0%	0	0.0%	0	0.0%	0	0.0%	-
Raised triglyceride (≥150 mg/dl)	Male	3	6.1%	25	51.0%	14	28.6%	7	14.3%	0.303
	Female	2	14.3%	6	42.9%	6	42.9%	0	0.0%	0.571
Raised LDL-C (≥100 mg/dl)	Male	0	0.0%	19	55.9%	7	20.6%	8	23.5%	0.007
	Female	1	9.1%	4	36.4%	5	45.5%	1	9.1%	0.535
Low HDL-C (< 40 mg/dl)	Male	1	2.2%	29	63.0%	11	23.9%	5	10.9%	0.035
	Female	1	11.1%	2	22.2%	5	55.6%	1	11.1%	0.262
Impaired FBS (>110 mg/dl)	Male	1	3.8%	15	57.7%	6	23.1%	4	15.4%	0.608
	Female	0	0.0%	1	20.0%	4	80.0%	0	0.0%	0.194
Increased BMI (>25 kg/m^2)	Male	2	11.8%	9	52.9%	4	23.5%	2	11.8%	0.994
	Female	0	0.0%	2	66.7%	1	33.3%	0	0.0%	0.694
Increased WHR	Male	2	6.9%	16	55.2%	7	24.1%	4	13.8%	0.915
	Female	3	15.0%	7	35.0%	9	45.0%	1	5.0%	0.445
Increased WC (cms)	Male	0	0.0%	2	50.0%	1	25.0%	1	25.0%	0.811
	Female	1	20.0%	2	40.0%	2	40.0%	0	0.0%	0.959
Increased lipoprotein- a (≥30 mg/dl)	Male	0	0.0%	20	47.6%	14	33.3%	8	19.0%	0.001*
	Female	0	0.0%	1	12.5%	6	75.0%	1	12.5%	0.016*

Table 3. Distribution of Risk Factors with Number of Vessels Affected

SVD- single vessel disease, DVD – double vessel disease, TVD – triple vessel disease, N – number of patients, HTN – hypertension, DM – diabetes mellitus, BMI – body mass index (kg/m^2), WHR – waist hip ratio, FBS – fasting blood glucose.

		LAD Involvement		P value	LCX Involvement		P value	RCA Involvement		P value
		N	%		N	%		N	%	
Sex	Male	58	72.5%	0.783	27	33.8%	0.766	26	32.5%	0.852
	Female	16	69.6%		7	30.4%		7	30.4%	
History of HTN	Male	19	70.4%	0.761	11	40.7%	0.345	11	40.7%	0.261
	Female	11	73.3%	0.591	6	40.0%	0.172	5	33.3%	0.679
History of DM	Male	18	69.2%	0.650	8	30.8%	0.696	11	42.3%	0.194
	Female	4	57.1%	0.392	4	57.1%	0.066	2	28.6%	0.898
Family history of CAD	Male	11	78.6%	0.575	5	35.7%	0.864	6	42.9%	0.362
	Female	2	66.7%	0.907	2	66.7%	0.144	0	0.0%	0.219
Raised cholesterol (≥200 mg/dl)	Male	6	85.7%	0.412	3	42.9%	0.594	2	28.6%	0.816
	Female	0	0.0%	-	0	0.0%	-	0	0.0%	-
Raised triglyceride (≥150 mg/dl)	Male	36	73.5%	0.807	18	36.7%	0.478	20	40.8%	0.046*
	Female	9	64.3%	0.493	4	28.6%	0.809	5	35.7%	0.493
Raised LDL-C (≥100 mg/dl)	Male	29	85.3%	0.028*	15	44.1%	0.092	13	38.2%	0.346
	Female	8	72.7%	0.752	4	36.4%	0.554	5	45.5%	0.134
Low HDL-C (< 40 mg/dl)	Male	37	80.4%	0.064	15	32.6%	0.802	14	30.4%	0.646
	Female	8	88.9%	0.106	5	55.6%	0.036*	2	22.2%	0.493
Impaired FBS (>110 mg/dl)	Male	20	76.9%	0.539	8	30.8%	0.696	11	42.3%	0.194
	Female	4	80.0%	0.567	3	60.0%	0.104	2	40.0%	0.599
Increased BMI (>25 kg/m^2)	Male	11	64.7%	0.417	6	35.3%	0.879	6	35.3%	0.782
	Female	3	100.0%	0.219	1	33.3%	0.907	0	0.0%	0.219
Increased WHR	Male	21	72.4%	0.990	11	37.9%	0.551	10	34.5%	0.775
	Female	15	75.0%	0.144	7	35.0%	0.219	6	30.0%	0.907
Increased WC (cms)	Male	3	75.0%	0.909	2	50.0%	0.481	2	50.0%	0.443
	Female	4	80.0%	0.567	2	40.0%	0.599	0	0.0%	0.095
Increased lipoprotein-a (≥30 mg/dl)	Male	34	81.0%	0.075	20	47.6%	0.006*	18	42.9%	0.038*
	Female	8	100.0%	0.021*	5	62.5%	0.015*	3	37.5%	0.591

Table 4. Distribution of risk factors with vessels involved

LAD – left anterior descending artery, LCX – left circumflex artery, RCA – right coronary artery, * significant positive correlation, HTN – hypertension, DM – diabetes mellitus, BMI – body mass index (kg/m^2), WHR – waist hip ratio, N – number of patients.

In the study there was no significant association between various risk factors and vessel involved among both males and females except for LDL-C (mg/dl) among males and Lipoprotein-a (mg/dl) among females in subjects with LAD involvement, HDL for females, and lipoprotein-a among males and females both in LCX vessel and triglyceride among males and lipoprotein-a among males for RCA vessels from Table 4.

	Group						
	CAD		Insignificant CAD		Total		P Value
	Mean	SD	Mean	SD	Mean	SD	
BMI (kg/m^2)	22.56	2.83	22.85	2.21	22.85	2.21	0.83
Waist hip ratio	0.89	0.06	0.85	0.05	0.88	0.05	0.01*
Waist circumference (cms)	87.47	9.65	84.83	6.08	87.16	6.08	0.27
Hip circumference (cms)	97.86	8.815	98.91	6.12	98.91	6.12	0.58

Table 5. Anthropometric Parameters Distribution among Subjects with and without CAD

Correlations					
			Number of Vessels	BMI (kg/m2)	Waist-Hip-Ratio
Spearman's rho	No. of vessels	Correlation coefficient	1.000	-0.008	0.226*
		P value	.	0.938	0.022*
		N	103	103	103

Table 6. Correlation between Number of Vessels with BMI and WHR

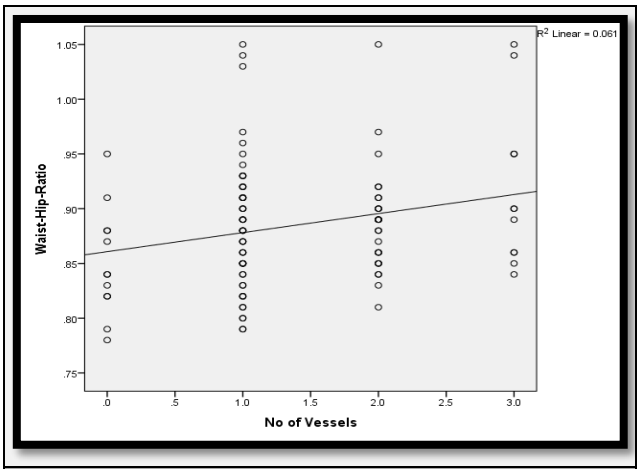

Figure 1. Scatter Plot showing Correlation between Number of Vessels with WHR

* Significant correlation.

In the study according to Spearman's rho correlation there was significant positive correlation between number of vessels involved and waist hip ratio, that is with increase in WHR there was increase in number of vessels affected and vice versa. There was no significant correlation between BMI and number of vessels involved from Table 5 and 6.

DISCUSSION

In the current study, WHR was found to be superior compared to BMI in assessing severity of CAD, as evidenced by the fact that as significant positive correlation was found between WHR and number of vessels involved in CAD, according to spearman correlation. Among 103 patients included in the study 77.66 % accounted for males and the rest (22.33 %) were females. Majority of the patients (88.34 %) had CAD -68 % had STEMI and 21.4 % had NSTEMI. Among those with CAD 50.5 % had SVD, 27.2 % had DVD and 10.7 % had TVD. Also, in this observational study, lipoprotein-a level showed a significant association with severity of CAD.

A study conducted in PGIMER, Chandigarh, also revealed similar findings where 83% of those with CAD were males.[8]

In this study, raised levels of LDL-C among males was found to be associated with increased involvement of LAD, while females LDL-C levels did not show significant association CAD. Among females, low HDL-C level showed significant association with LCX vessel involvement (55.6 %). The study also showed that there was an increased incidence of SVD, DVD, TVD both in males (476 %, 33.3 %, 19.0 % respectively) and females (12.5 %, 75.0 %, 12.5 % respectively) with a p-value < 0.05 in relation to Lp (a) level and severity of CAD. In agreement with current study, a study conducted to find association of WHR with angiographic severity of CAD in patients with STEMI, showed that 46.7% patients with CAD had history of dyslipidaemia.[9] According to results of a study conducted in KGMU, Lucknow there was a highly significant difference in levels of Triglyceride between CAD and non-CAD. A highly significant difference was also observed in levels of VLDL between CAD and non-CAD patients. However, HDL was significantly lower in CAD patients as compared to non-CAD. Also, Lp (a) level was significantly higher in CAD compared to non-CAD patients. According to this study Lp (a) level of 21.0mg/dl were not only associated with CAD but also with severity of coronary atherosclerosis.[10]

In the current study, no significant association was found between hypertension and diabetes mellitus. In a prospective cross-sectional case control study conducted to Relook at Lp (a): Independent risk factor of CAD in North India population, among conventional risk factors like diabetes mellitus, hypertension, only diabetes mellitus was found to be higher among cases compared to controls.[11] The results of a cross sectional observational study conducted to assess association of WHR with angiographic severity of CAD in patients with acute STEMI showed that hypertension and diabetes mellitus were higher among those with increased WHR which was further associated with increased CAD incidence.[9]

Among patients with CAD, mean WHR =0.89 ± 0.06 (p=0.01), mean BMI (kg/m^2) = 22.56 ± 2.83(p=0.83), mean WC (cms) = 87.47 ± 9.65 (p=0.27) and mean HC (cms) = 97.86 ± 8.81 (p=0.58). In the present study, according to Spearman's rho correlation, there is a significant positive correlation between WHR and number of vessels involved (correlation coefficient = 0.226, p=0.02), while there was no positive correlation between number of vessels involved and BMI (correlation coefficient = -0.008, p=0.938).

A similar study was conducted by Premtim Rashiti, Ibrahim Behluli, Albiona Rashiti Bytyqi (2017) in Kosovar to assess the correlation between severity of CAD and waist hip-ratio, as a measurement of obesity as severity of CAD. The study was conducted on 82 patients. The study compared the two groups, CAD and non-CAD. There was significant positive correlation between waist-hip ratio among the CAD patients and it also showed that there is increased severity of CAD in the form of number of vessels affected with increased waist hip ratio.[12]

Another supporting study conducted by Amir Farhang Zand Parsa, Bahareh Jahanshahi (2011) to assess the relationship of body mass index to severity of coronary artery disease which is different from that of waist to hip ratio and severity of coronary artery disease. It was a cross sectional, prospective study where 414 patients with suspected coronary artery disease in whom coronary angiography was performed were enrolled. According to SYNTEX and Duke scores, there was a negative correlation between severity of CAD and BMI.[13]

One more study was done by Baghbani-Oskouei A, Gholampourdehaki M. in University of Medical Sciences, Tehran, Iran. Their finding related that, of the anthropometric

measurements WHR, WC and BMI were significantly associated with increased risk of CAD, the corresponding ORs (95% CI) were 1.34 (1.04-2.18), 1.36 (1.21-1.52) and 1.71 (1.08- 2.29) respectively.[14]

According to TA Welborn and SS Dhaliwal who conducted a study of an eleven-year mortality follow up of an Australian urban population, among 9309 aged 20-69 years, using ROC curves to assess sensitivity and specificity of measures, it was found that increased WHR, BMI, WC was associated with higher rate of CVD mortality, among both males and females. Also, it concluded that WHR was by far more superior predictor of hazard ratios and their high statistical significance.[15]

In a prospective study conducted in Himachal Pradesh, India by Sharanjit Kaur, Anand Sharma, Harinder Jot Singh, waist related anthropometric measurements were compared to BMI as a predictor of CVD risk factors in women. From this study done on 88 women aged 40-80 years, it was concluded that central obesity markers such as WHR, WC show higher specificity and sensitivity than BMI.[16]

The INTERHEART study which is a case-control study done in 52 countries assessed the modifiable risk factors associated with myocardial infarction concluded that WHR had significant correlation compared to BMI in causing myocardial infarction.[17]

In a study done at Department of Cardiology, GB Pant hospital, Delhi, among 150 patients each of SVD, DVD, TVD with 150 controls, it was established that raised lipoprotein-a level ≥ 40mg/dl assessed by isoform incentive assay, was an independent risk factor for CAD. Also raised Lp (a) levels was associated with increased risk of ACS and multivessel CAD.[11]

CONCLUSIONS

There is a significant positive correlation between the WHR and number of vessels affected compared to the BMI with the severity of CAD. Elevated lipoprotein-a levels and LDL-C levels signifies that they are also independent predictors of the severity of CAD assessment.

Limitations of the Study

The study is non randomized study and sample size is small, which might not be representative of the entire population with coronary artery disease as only symptomatic patients were enrolled. It was studied at single centre. Other risk factors like hypertension, diabetes mellitus, family history and smoking were added into the account which they will act like confounding factors in causing the coronary artery disease.

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