Obesity and Coronary Intervention: Should We Continue to Use Body Mass Index as a Risk Factor?

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Summary

Background: Central anthropometric indexes are better than the body mass index to discriminate elevated coronary risk. However, the Body Mass Index (BMI) is still the most frequently studied anthropometric index on outcomes of patients undergoing percutaneous coronary angioplasty (PCI).

Objective: To recognize, among several anthropometric indexes of obesity, which one best discriminates MACE (Major Adverse Cardiac Events) after PCI.

Methods: Subjects were 308 patients (mean age 61.92±11.06 years, 60.7% of them men) who had undergone successful coronary angioplasties. Six months after the procedure, patients were contacted for clinical follow-up. Major Adverse Cardiac Events included death, acute myocardial infarction, cardiac surgery, reintervention, angina, or evidence of myocardial ischemia on a non-invasive test. Patients were divided into 2 groups: Group 1 (with MACE, n=91, 29.5%), Group 2 (with no MACE, n= 217; 70.45%). For men and women, the anthropometric indexes studied and their respective cut-off points were waist circumference >90/80 cm, Waist-Hip Ratio > 0.90/0.80cm, Conicity Index > 1.25/1.18, and Body Mass Index ≥ 30.

Results: There were more cases of familial history and previous infarct in Group 2. For men, waist circumference >90cm (p=0.0498) in multivariate analyses was an independent predictor of MACE. BMI was not related to MACE. In Group 1, the prevalence of an elevated BMI was significantly different compared to the other anthropometric indexes studied (p<0.0001).

Conclusion: Waist circumference was an independent predictor of MACE in men. Body Mass Index was not related to MACE and was the least frequent anthropometric index in the MACE group. (Arq Bras Cardiol 2008; 90(5): 284-289)

Key words: Obesity; antropometry/methods; body mass index; angioplasty, transluminal, percutaneous coronary.

Introduction

Since 1983 when the results of the Framingham Study related to obesity were published, a strong correlation between this risk factor and coronary artery disease has been observed[1]. In Brazil, the prevalence of obesity is approximately 8% for men and 12.4% for women[2]. The joint effect of overweight and obesity reaches figures of around 38.5% and 39% for men and women, respectively. In the United States, this rate is approximately 30.5% and 64.5%, for men and women, respectively i.e., more than half of the North American population is overweight or obese[3].

Using the BMI as a marker for obesity, significant epidemiological studies have shown that obesity is associated with cardiovascular morbidity and mortality[1,4]. The association of obesity with conventional risk factors, such as arterial hypertension and diabetes mellitus, and with endothelial dysfunction, insulin resistance, and inflammation may contribute to the increase in untoward outcomes after Percutaneous Coronary Interventions (PCI) in obese individuals[5].

Despite evidence of risk conferred by an elevated BMI, there are reports in literature of a paradoxal protection afforded by obesity in patients submitted to PCI[6-9]. Thus, in these publications, patients with high BMIs showed lower rates of cardiac events in one year[6,7], lower risks of intrahospital events[8], and lower mortality rates after the procedure[9].

Although the BMI is a simple and convenient measurement considered valid up until now for the study of obesity, measurements of central obesity (primarily Waist Circumference and altered Waist-Hip Ratios)[10] have proved to be more closely related both to elevated coronary risks[11,12] and to acute myocardial infarcts[13,14]. Even so, to date, BMI is the anthropometric index most used in interventional cardiology for clinical follow-up after a coronary intervention.

The objective of this study is to recognize, among several anthropometric indices of obesity, those that best correlate with the occurrence of post-PCI outcomes.

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Methods

The sample is composed of 308 consecutive patients, mean age 61.92±11.06 years (varying from 34 to 88 years), 60.7% of them male, successfully submitted to PCI with a conventional stent during the period from May 2005 to September 2006. For all study subjects, a routine medical history was taken with the collection of information on risk factors for coronary disease. Patients were submitted to physical examinations, with weight and height measurements. The BMI was calculated by the weight in kilograms divided by the height in square meters (kg/m^2). Obesity was considered when BMI ≥ 30. The Waist/Abdominal Circumference (WC), obtained with the patient wearing the least amount of clothing possible, was measured at mid-distance between the last floating rib and the iliac crest. Hips were measured using as reference the femoral trochanters. The Waist-Hip Ratio (WHR) was determined by dividing the Waist Circumference by the Hip Circumference (HC). The Conicity Index (CI) was determined using measurements of body weight, height, and wais circumference, with the following equation:

$$C\ index = \frac{Waist\ Circumference\ (m)}{0.109x\sqrt{\frac{Body\ Weight\ (kg)}{Height\ (m)}}}$$

CPIs were carried out via femoral artery using a technique chosen by current consensus[15]. Patients were pretreated with double platelet inhibition, receiving aspirin 100mg and ticlopidine 250mg, twice a day, initiated 48 hours before, or clopidogrel 75mg (initiated at least 24 hours before the procedure, once a day, or with a loading dose of 300mg 6 hours before the procedure), and this approach was maintained for 30 days after the intervention. No patient received glycoprotein IIb/IIIa inhibitors. Success in the procedure was defined as the achievement of residual stenosis < 30%, with no occurrence of a significant clinical event (death, acute myocardial infarct (AMI), or need for emergency surgery), during the hospital phase.

After a 6-month period, patients were contacted in search of the following outcomes: death, reintervention with PCI or vessel-related heart surgery, non-invasive test altered by ischemia, acute myocardial infarct, or recurrence of anginous symptoms[16,17]. Outcomes were considered the most serious events reported. The occurrence of unfavorable outcomes was correlated with the anthropometric indices obtained. In men and women, the anthropometric indices studied and their respective cut-off points for both genders were Waist Circumference > 90/80cm, Waist-Hip Ratio >0.90/0.80cm[18], Conicity Index >1.25/1.18[11], and Body Mass Index (BMI) ≥30[19].

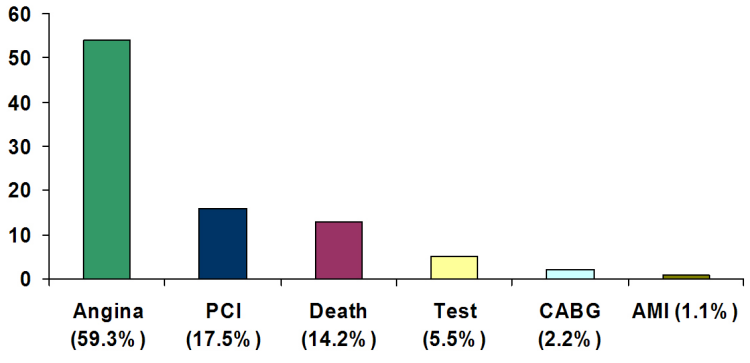
As to statistical analyses, the groups were compared with the use of dichotomic variables, Fisher's Exact Test, and, for continuous variables, Student's t Test (independent samples), except for the "initial lesion and residual lesion" variables which were analyzed with the Mann-Whitney non-parametric test. To study dichotomized anthropometric variables, Fisher's Exact Test and Wald's Test were used. In order to verify the prevalence of abnormality of each anthropometric index studied, the Binomial Test was used. All anthropometric variables studied were submitted to univariate and multivariate analyses. P values less than 5% ($p<0.05$) were considered significant.

Results

Three hundred and eight patients who successfully received metallic stent implants between May 2005 and September 2006 were studied. According to the outcomes, they were divided into Group 1 (with outcomes, n=91; 29.5%) and Group 2 (no outcomes, n=217; 70.45%). Graphic 1 demonstrates the proportion of outcomes found in patients who experienced events. Characteristics of the population studied are listed on Table 1.

A statistically significant difference was observed between the groups for the items familial history of coronary disease and prior infarct, more prevalent in Group 2 (p=0.02 and 0.03, respectively). The other clinical and angiographic characteristics were similar between the groups. The rates of immediate success, mean final stenosis, and complications were similar between the two groups.

No independent influence was shown of the variables studied on the occurrence of events in the univariate and



Graphic 1 - Proportion of outcomes found in the population studied. PCI - percutaneous coronary intervention; death - occurrence of death related to PCI, Test - non-invasive test positive for ischemia, CABG - need for vessel-related cardiac surgery, AMI - acute myocardial infarct.

multivariate statistical analyses (the latter included all altered anthropometric parameters available, except the Waist-Hip Ratio) of the occurrence of altered anthropometric indices and outcomes in the general population and in women. In men, on the other hand, the Waist Circumference >90cm in the multivariate analysis (p=0.0498) was independently related to the occurrence of outcomes. The BMI was not a predictor of events in either gender (Tables 2, 3 e 4).

Despite the fact that most of the patients in the sample had abnormal anthropometric indices, we noted the order of occurrence of each altered anthropometric measurement in the group with outcomes. In this way, in Group 1, the probability of the occurrence of abnormal Waist Circumferences (61.36%), Waist-Hip Ratios (94.48%), and Conicity Indices (64.29%) is significantly different from the probability of BMI abnormalities (26.30%), with p<0.0001 for all combinations (Table 5).

Table 1 - Clinical and angiographic characteristics of the patients studied

	Group 1 (with outcomes) n=91	Group 2 (no outcomes) n=217	P value
Age	60.63±11.61	62.46±10.82	0.1882
Males	52(57.1%)	135(62.2%)	0.4438
Low educational level	52(57.1%)	122(56.2%)	0.9004
BMI	27.60±4.71	27.54±4.39	0.9066
WC	92.15±13.44	92.78±13.06	0.7022
Hip	93.42±10.06	91.34±12.09	0.1493
WHR	0.99±0.12	1.02±0.12	0.0764
CI	1.26±0.12	1.26±0.11	0.9437
Unstable angina	26(28.6%)	60(27.6%)	0.8898
Primary angioplasty	9(9.89%)	12(5.52%)	0.2138
SAH	72(79.1%)	160(73.7%)	0.3851
DM	36(39.6%)	66(30.4%)	0.1443
Smoking	20(22.0%)	45(20.7%)	0.8785
Sedentary lifestyle	53(58.2%)	118(54.4%)	0.6154
Familial history	27(29.7%)	95(43.8%)	0.0220
Hypercholesterolemia	46(50.6%)	99(45.6%)	0.4545
Previous AMI	18(19.8%)	69(31.8%)	0.0374
Stress	22(24.2%)	73(33.6%)	0.1067
PCI AD	32(39.6%)	88(40.6%)	0.8993
Initial lesion	86.95±10.62	84.49±10.80	0.0614
Residual lesion	2.64±6.12	3.63±8.13	0.4447
B2/C-type lesions	73(80.2%)	166(76.5%)	0.5500
Located in initial third	43(47.2%)	126(58.1%)	0.1026
Extension of the lesion (mm)	16.12±6.06	17.03±6.30	0.2451
Diameter of the vessel (mm)	2.96±0.74	2.92±0.47	0.6394

BMI - Body Mass Index, WC - Waist Circumference, Hip - Hip Circumference, WHR - Waist-Hip Ratio, CI - Conicity Index, SAH - Systemic Arterial Hypertension, DM - Diabetes Mellitus, PCI AD - angioplasty of the anterior descending artery, Initial lesion - diameter of the pre-angioplasty obstructive lesion, Residual lesion - diameter of the post-angioplasty obstructive lesion, B2/C - treated lesions types B2 and C, Initial third - treated lesion located in the initial third portion of the artery.

Discussion

In this study of patients submitted to PCI with a conventional stent, it was noted that the altered waist circumference stands out as an independent predictor for the occurrence of late outcomes in the male sub-group. The BMI was not associated with a better or worse clinical progress after PCI.

Various studies published have shown the existence of a protective effect of obesity (according to the BMI) in patients submitted to PCI. Gruberg et al[6] reported a lower number of cardiac events in obese individuals, a protection that remained for up to one year after the PCI. Ellis et al[20], before the advent of stents, observed poorer intrahospital clinical developments only in patients with extreme BMIs (equal to or lower than 25 and greater than 35), and this finding is a predictor of death after PCI[20]. There are reports of greater risks of vascular complications in patients with extreme BMIs when compared to moderate obesity, which supports the existence of a paradox of obesity[21]. In studying patients submitted to the primary PCI in the Cadillac study, Nikolski et al[9] observed a correlation between elevated BMIs and lower mortality[9]. In evaluating the relationship between the BMI and one-year clinical progress after PCI, Kelly et al[7] observed that the BMI was associated with greater efficacy and less bleeding after PCI. In this sample, there was an extra advantage for patients with high BMIs randomized to receive clopidogrel[7]. The so-called "obesity paradox" has also been observed in patients after heart surgery[22] and in those with congestive heart failure[23]. The BARI study reported a better short-term clinical progress in obese individuals in the PCI arm, and the BMI showed no association with the 5-year mortality rate[8]. Presently, there is no plausible explanation for the paradoxal protection of obesity. A greater

Table 2 - Univariate and multivariate analyses of the anthropometric indices in the general population *versus* outcomes

Variable	Group 1 (with outcomes) n=91	Group 2 (no outcomes) n=217	Univariate p value	Multivariate p level
BMI ≥ 30	23 (25.3%)	58 (26.7%)	0.8874	0.5219
WC: > 90 male ; > 80 fem	59 (64.8%)	130 (59.9%)	0.4438	0.2744
CI: > 1.25 male; > 1.18 fem	60 (65.9%)	138 (63.6%)	0.7945	0.7972

BMI - Body Mass Index, WC - Waist Circumference, CI - Conicity Index, male - male, fem - female.

Table 3 - Univariate and multivariate analyses of the anthropometric indices in men *versus* outcomes

Variable	Group 1 (with outcomes) n=52	Group 2 (no outcomes) n=135	Univariate p value	Multivariate p value
BMI ≥ 30	15 (28.8%)	39 (28.9%)	1	0.6989
WC > 90	30 (57.7%)	74 (54.8%)	0.7453	0.0498
CI > 1.25	28 (53.8%)	83 (61.5%)	0.4065	0.1030

BMI - Body Mass Index, WC - Waist Circumference, CI - Conicity Index.

Table 4 - Univariate and multivariate analyses of the anthropometric indices in women *versus* outcomes

Variable	Group 1 (with outcomes) n=39	Group 2 (no outcomes) n=82	Univariate P value	Multivariate P value
BMI ≥ 30	8 (20.5%)	19 (23.2%)	0.8186	0.7011
WC > 80	29 (74.4%)	56 (68.3%)	0.5314	0.5053
CI: > 1.18	32 (82.1%)	55 (67.1%)	0.1290	0.0902

BMI - Body Mass Index, WC - Waist Circumference, CI - Conicity Index.

Table 5 - Probability of occurrence of abnormal AMI in Group 1

		BMI	WC	CI	WHR
	Percentage of abnormality	**26.30%**	**61.36%**	**64.29%**	**94.48%**
BMI	26.30%	-	<0.0001	<0.0001	<0.0001
WC	61.36%		-	0.2221	<0.0001
CI	64.29%			-	<0.0001
WHR	94.48%				-

BMI - Body Mass Index, WC - Waist Circumference, CI - Conicity Index, WHR - Waist-Hip Ratio.

coronary diameter in the obese, with a smaller chance for restenosis[8], and the influence of age, which may be lower in the obese patients studied, may have influenced the superior clinical course[24]; even excessive anticoagulation in patients with higher BMIs[6] is a possible mechanism to justify these findings in medical literature. More recently, Rubinstein et al[25] studied the severity of coronary artery disease in obese subjects submitted to PCI and concluded that the obese showed a smaller prevalence of serious coronary lesions, which might also explain the better clinical progress in this group of patients.

There is controversy, however, regarding this issue. Some studies have not shown the protective effect of obesity after coronary intervention: data from the TAXUS-IV study, with angiographic control post-PCI with metallic stent implantation, showed a worse clinical progress in the obese when compared to patients with normal BMIs[26]. A sub-analysis of the ARTS study[27], in observing outcomes three years after PCI or cardiac surgery, failed to show any association between the BMI and significant cardiac events. Rana et al[24] did not note any relationship between the metabolic syndrome or any of its components (among them, an elevated BMI) and a smaller occurrence of post-PCI outcomes. Poston et al[28], in evaluating the impact of obesity after PCI (quality of life or health status after 12 months in one large cohort of patients with 1631 individuals), perceived that there was no long-term difference in health status, quality of life, need for repeated procedures, or survival in the different classifications of BMI[28]. This author, when studying 903 patients after angioplasty with conventional stents, found no protection afforded by obesity against outcomes 6 months after the procedure. In the normal BMI, overweight, and obese groups, the occurrence of untoward events did not differ significantly[29].

Although anthropometric indices of central obesity bear a better correlation with coronary events[14], high coronary risk[11], and AMI[13], there are no studies correlating them with the clinical progress after PCI. In fact, despite the fact that BMI is a simple and convenient measurement for the diagnosis of obesity, the importance of the deleterious effect of abdominal obesity on coronary artery disease is increasingly more evident[10]. Compared to the BMI, the Waist Circumference, Conicity Index, and Waist-Hip Ratio have proved to be superior for identifying visceral adiposity and, consequently, metabolic disorders and cardiovascular risk[12]. In a study on risk factors in the city of São Paulo and in INTERHEART, a high Waist-Hip Ratio (intermediate tercile versus the inferior tercile) was independently associated with AMI, which did not occur with an altered BMI[13,14].

All these recent findings on the importance of central

obesity (Waist Circumference, Waist-Hip Ratio, and Conicity Index) in detriment of generalized obesity measurements (BMI), added to the results of this study, lead us to question the true existence of the paradox of obesity, a finding based merely on the calculation of the BMI. Additional research - especially with a greater number of individuals allocated - on the influence of anthropometric indices on the interventional cardiology scene should be carried out for definitive conclusions on the theme.

Limitations of the study - Since it is a populational sample of the real world comprised by consecutive patients submitted to PCI, most of the women presented central obesity, which could explain the statistical non-significance in this group. Since there was a high percentage of abnormality (94.48%) in the Waist-Hip Ratio in the general population, with an absence of cases in the group of women with Waist-Hip Ratios ≤ 0.80, this anthropometric measurement was not included in the Logistic Regression model. The sample size and level of significance should be taken into consideration in interpreting the results, and the reader should await larger studies in order to confirm the hypotheses presented.

Conclusion

Abnormal Waist Circumference, an anthropometric index that reflects central obesity, behaved as an independent predictor of the occurrence of outcomes in the male individuals of this population post-PCI. An elevated BMI was not a predictor of outcomes in either gender, and was the least prevalent anthropometric index in patients with outcomes, despite being the most frequently used in worldwide literature.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any graduation program.

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