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Original Article CARDIOLOGY

Urban legend or real fact: Coronary artery size varies with demographics

Mustafa Adem Tatlisu,[1] Murat Sargin,[2] Adnan Kaya,[3] Ahmet Ilker Tekkesin,[3] Zekeriya Nurkalem,[4] Serap Aykut Aka[2]

[1]Department of Cardiology, Sivas Numune State Hospital, Sivas, Turkey

[2]Department of Cardiovascular Surgery, Dr. Siyami Ersek Cardiovascular Surgery Research and Training Hospital, Istanbul, Turkey

[3]Department of Cardiology, Dr. Siyami Ersek Cardiovascular Surgery Research and Training Hospital, Istanbul, Turkey

[4]Department of Cardiology, Istanbul Medipol University Faculty of Medicine, Istanbul, Turkey

ABSTRACT

OBJECTIVE: This study aimed to determine the relationship between the diameter of coronary artery stents and age, gender, diabetes mellitus (DM), left ventricular ejection fraction (LVEF), renal dysfunction, and the clinical presentation of myocardial ischemia in the cohort of patients with implanted stents in coronary arteries with severe stenotic lesions.

METHODS: This study included 2256 patients (mean age, 59.3±10.9 years; men, 62%) who underwent percutaneous coronary intervention (PCI). The clinical status of the patients at presentation was subcategorized as follows: ST-segment elevation myocardial infarction, non-ST segment elevation myocardial infarction, unstable angina pectoris, and stable angina pectoris. The diameters, without any type or brand differentiation, were divided into two groups as follows: Group I, which included 2.5- and 2.75-mm-diameter stents, and Group II, which included ≥3-mm-diameter stents.

RESULTS: The type of procedure, including primary PCI, early invasive strategy, and elective stenting, was not found to be a significant factor affecting the diameter of coronary artery stents. Univariate and multivariate analyses revealed a relationship between the diameter of coronary artery stents and age, gender, DM, and LVEF.

CONCLUSION: This study demonstrated that the diameter of coronary artery stents was independently associated with gender, age, a history of DM, and moderate-to-severe systolic left ventricular dysfunction.

Keywords: Coronary artery stent diameter; diabetes mellitus; effect; percutaneous coronary intervention.

Gender, age, and diabetes mellitus (DM) are some of the many claimed factors that affect the outcomes of coronary artery diseases related to mortality [1]. Besides these, the diameter of coronary artery is another parameter affecting the outcomes [2]. Several studies have shown that the luminal diameter after percutaneous revascularization is a strong predictor of restenosis [3, 4]. Similarly, in coronary artery bypass surgery (CABG), the target vessel size correlates with long-term graft patency [5, 6]. Several angiographic and autopsy studies have examined the possible relation between coronary arterial size and gender differences, and most of these studies have shown that women have smaller diameters of coronary artery [7, 8]. DM and gender are other possible parameters that are related to coronary artery sizes.

However, a study of the diameters of coronary artery has several limitations, such as in cases of patients with angiographically normal coronary arteries or with an eccentric disease, diffuse atherosclerosis, and arterial compensatory enlargement or a study using nonstandard-

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Correspondence: Dr. Mustafa Adem TATLISU. Sivas Numune Devlet Hastanesi Kardiyoloji Anabilim Dali, Sivas, Turkey.
Tel: +90 536 443 99 06 e-mail: ademtatlisu@gmail.com

ized measurement techniques. In patients with coronary artery stents, the diameter of the implanted stents reflects the diameter of the coronary vessel at the lesion. Our study aimed to determine the relationship between the diameter of coronary artery stents and age, gender, DM, left ventricular ejection fraction (LVEF), renal dysfunction, and the clinical presentation of myocardial ischemia in a cohort of patients with implanted stents in coronary arteries with severe stenotic lesions.

MATERIALS AND METHODS

Study Participants

Our retrospective study included 2256 consecutive patients undergoing stent implantation to native coronary artery at Dr. Siyami Ersek Cardiovascular and Thoracic Surgery Training and Research Hospital, which serves as a tertiary catheterization laboratory of a high volume center [1194 primary percutaneous coronary intervention (pPCI) and 2032 elective PCI were performed by 25 interventional cardiologists in 2010] between January 1 and December 31, 2013. Patients with native coronary stent implantation were included. A total of 46 patients were excluded because of the fact that transthoracic echocardiography was not performed in the first 24 h of admission. Demographic parameters were defined as age, gender, DM, LVEF, and creatinine levels. Creatinine levels and LVEF values were recorded before PCI. The clinical status of the patients at presentation was subcategorized as follows: ST-segment elevation myocardial infarction (STEMI), non-ST segment elevation myocardial infarction (NSTEMI), unstable angina pectoris (USAP), and stable angina pectoris (SAP). Stent diameters varied from 2.5 to 4 mm. The diameter of stents, without any type or brand differentiation, was divided into two groups as follows: Group I, which included 2.5- and 2.75-mm-diameter stents, and Group II, which included ≥3-mm-diameter stents. This study was approved by the Institutional Ethics Committee.

Analysis of Patient Data

Data on the clinical history of risk factors, such as age, gender, hypertension, DM, hyperlipidemia, and renal insufficiency was collected from the hospital's medical database. Echocardiographic and coronary angiographic findings were also obtained from the same database. A transthoracic echocardiogram was performed in 98% of patients in the first 24 h of admission to the coronary care unit, and LVEF was calculated using the Simpson method [9]. Patients with LVEF ≤40% were considered to have moderate-to-severe left ventricular systolic dysfunction [10]. Non-ionic low osmolality contrast media (616 mosmol/kg) were used in all patients. Patients with creatinine levels of ≥1.4 mg/dL were considered to have renal insufficiency [11, 12]. After coronary angiography or pPCI, patients were admitted to the coronary care unit for follow-up. Drugs were administered during and after hospitalization as per the European Society of Cardiology Guidelines [13-15]. Blood values obtained from venous blood samples at hospital admission were recorded from medical reports. White blood cell counts, hemoglobin levels, and platelet counts were measured as part of the automated complete blood count using a Coulter LH 780 Hematology Analyzer (Beckman Coulter Ireland, Inc, Galway, Ireland). Biochemical measurements were performed using Siemens Healthcare Diagnostic Products kits and calibrators (Marburg, Germany). Creatine kinase isoenzyme–MB (CK-MB) levels were measured using an immune-inhibition method (Architect C 8000; Abbott Inc).

Analysis of Patient Data

All STEMI patients underwent pPCI within 1 h of admission, and all NSTEMI patients underwent PCI within 24 h of admission. All PCI procedures were performed using the standard femoral approach with a 6-Fr guiding catheter. Medication before pPCI included 600 mg of clopidogrel and 300 mg of chewable aspirin. Direct stenting was performed whenever possible, and balloon predilatation was performed in the remaining cases. The drug-eluting stent was used whenever possible. To achieve maximal dilation, an intracoronary injection of nitroglycerin (100 μg) was administered in each coronary angiogram. All patients were treated with maintenance doses of clopidogrel (75 mg, once daily for 12 months) and aspirin (100 mg, indefinitely).

Statistical Analysis

Kolmogorov-Smirnov test was used for testing the normality. Continuous variables with normal distributions were expressed as mean±SD and compared using one-way analysis of variance. Continuous variables with skewed distributions were expressed as median (25th and 75th percentiles) and compared using Kruskal–Wallis test. Categorical variables were expressed as number and percentages, and Pearson's chi-square or Fisher's exact tests were used to evaluate the differences. Differ-

ences between the groups were analyzed using the log-rank test. A forward Cox proportional regression model was used for multivariable analysis. In multivariable models, confounders in bivariate analysis as predictors of coronary stent diameter determinators were considered. A two-tailed p-value of <0.05 was considered statistically significant, and 95% CIs were presented for all odds ratios and hazard ratios. Analyses were performed using Statistical Package for Social Sciences software, version 20.0 (SPSS; IBM, Armonk, New York, USA).

RESULTS

A total of 2256 patients (mean age, 59.3±10.9 years; men, 62%) undergoing stent implantation to native coronary artery were included. Patients' baseline characteristics are listed in Table 1. Of the patients, 30.3% had DM, 13.9% had renal dysfunction, and 71.8% had systolic left ventricular dysfunction, as shown in Table 1. With respect to the clinical status of patients at presentation, the percentages of patients were as follows: STEMI, 56.2%; NSTEMI and USAP, 24.2%; and SAP, 19.7%. Of the patients, 19.5% received coronary artery stents of <3-mm diameter.

Table 1. Baseline characteristics of patients

	n=2256 (%)
Age	59.3±10.9
Aged ≥65	783 (34.7)
Gender (male)	1399 (62)
Diabetes mellitus	684 (30.3)
Left ventricular ejection fraction (≤40%)	1621 (71.8)
Creatinine (≥1.4 mg/dL)	314 (13.9)
Patients' status at admission	
ST-segment elevation myocardial infarction	1267 (56.2)
Non-ST segment elevation myocardial infarction, Unstable angina pectoris	545 (24.2)
Stable angina pectoris	444 (19.7)
Coronary stent diameters	
<3 mm	440 (19.5)
≥3 mm	1816 (80.5)
Coronary arteries	
Left anterior descending artery	1270 (56.3)
Diagonal artery	194 (8.6)
Circumflex artery	55 (2.4)
Right coronary artery	737 (32.7)

Continuous variables are presented as median and 25-75 percentiles; nominal variables presented as frequency (%). Mann-Whitney-U test was used for continuous variables. Pearson-Chi-Square test was used for nominal variables.

Table 2 lists unadjusted and adjusted hierarchical logistic regression analysis for diameters of coronary artery stents. The type of the procedure, including pPCI, early invasive strategy, and elective stenting, was not found to be a significant factor affecting the diameter of coronary artery stents (Table 2). Although renal dysfunction was found to be a factor affecting the diameter of coronary artery stents in univariate analysis, this significant relationship did not persist after adjustment for all confounders. The significant relationship was found between the diameter of coronary artery stents and age, gender, DM, and LVEF in univariate analysis (p<0.001), which persisted even after adjusting for all confounders (Table 2).

DISCUSSION

Gender, age, chronic renal failure, congestive heart failure, and DM are significant predictors of clinical outcomes after PCI. Patients with smaller target vessels have a significantly higher rate of restenosis; however, this does not imply that coronary stents should not be placed into smaller vessels. A meta-analysis of 11 randomized trials has shown that stenting is superior to balloon angioplasty in small coronary vessels [16]. Although several studies have been conducted on vessel sizes with angiographically normal coronary arteries [17-19], those on vessel sizes with atherosclerotic coronary arteries are rare.

In multivariate analysis, age, a history of DM, systolic left ventricular dysfunction, and female gender were found to be associated with coronary vessel size. Our findings support those of previous studies on vessel sizes. Several studies have focused only on gender [17, 18]; therefore, we investigated the relationship between coronary vessel sizes and age, DM, LVEF, renal dysfunction, and the clinical presentation of myocardial ischemia. Before coronary intervention, interventional cardiologists have several preconceptions regarding elderly patients [20] and/or patients with DM that they have considerably smaller coronary vessels than other patients. Our findings were consistent with those observed in our practical experience. Because we received only coronary vessels that were intervened, we could not receive those that could not be intervened. As known by several interventional cardiologists, vessels that cannot be intervened are comparatively smaller than those that are intervened, particularly in patients with DM. Nevertheless, older age, DM, LVEF, and female gender were found to be as-

Table 2. Univariate predictors and multivariate hierarchical logistic regression analysis for coronary artery stent diameters. All clinically relevant parameters were included in the model

Univariate analysis	Stent size <3 mm n (%)	Stent size ≥3 mm n (%)	p	OR (95% CI)
Age (<65 years)	173 (11.7)	1300 (88.3)	<0.001	3.891 (3.134-4.830)
Gender (male)	164 (11.7)	1235 (88.3)	<0.001	3.577 (2.880-4.444)
Diabetes mellitus	192 (28.1)	492 (71.9)	<0.001	0.480 (0.387-0.595)
LVEF (≤40%)	358 (22.2)	1263 (77.9)	<0.001	0.523 (0.403-0.678)
Creatinine (≥1.4 mg/dL)	47 (15.0)	267 (85.0)	<0.05	1.442 (1.038-2.005)
Type of the procedure				
Primary PCI	276 (21.8)	981 (78.2)	>0.05	0.813 (0.618-1.069)
Early invasive strategy	82 (15.0)	463 (85.0)	>0.05	1.278 (0.914-1.788)
Elective stenting	82 (18.5)	362 (81.5)	>0.05	1.056 (0.729-1.365)
Multivariate analysis	**Stent size <3 mm n (%)**	**Stent size ≥3 mm n (%)**	**p**	**OR (95% CI)**
Age (<65 years)	173 (11.7)	1300 (88.3)	<0.001	4.791 (3.761-6.102)
Gender (male)	164 (11.7)	1235 (88.3)	<0.001	2.267 (1.762-2.914)
Diabetes mellitus	192 (28.1)	492 (71.9)	<0.001	0.569 (0.444-0.730)
LVEF (≤40%)	358 (22.2)	1263 (77.9)	<0.001	0.416 (0.307-0.562)
Creatinine (≥1.4 mg/dL)	47 (15.0)	267 (85.0)	0.08	1.231 (0.915-1.742)

Only parameters that reached statistical significance at univariate analysis were given in the rows below. OR: Odds ratio; CI: confidence interval; LVEF: left ventricular ejection fraction; PCI: percutaneous coronary intervention.

sociated with smaller final stent sizes in our study. Furthermore, we could not find the association between final stent size and the presentation of ischemic heart diseases such as STEMI, NSTEMI, USAP, and SAP. Although patients with STEMI have increased catecholamine and inflammatory cells that may cause coronary spasm during the procedure, we did not find any relationship between STEMI and diameters of coronary stents, which might be because of the routine intracoronary injection of nitroglycerin before stent implantation. Because of intracoronary nitrates, the implanted stent size in patients with STEMI reflects the appropriate final stent size.

Limitations

There are some limitations to our study. Forty-six patients were excluded because transthoracic echocardiography was not performed in the first 24 h of admission. Our study population was limited to patients undergoing PCI. Therefore, our results cannot be generalized to patients with normal coronary vessels. The study was conducted in a single tertiary referral heart center. Because high-risk patients are referred for PCI to our heart center, it may have affected our results. As shown in Table 1, 71.8% of the patients had moderate-to-severe systolic left ventricular dysfunction. Another limitation of the study is its retrospective design because of which we could not calculate the body mass index that may affect the diameter of coronary artery vessels and also could not utilize more accurate diagnostic tools, such as intravascular ultrasound and optical coherence tomography, to measure the diameter of vessels.

CONCLUSION

This study demonstrated that diameters of coronary artery stents were independently associated with gender, age, a history of DM, and moderate-to-severe systolic left ventricular dysfunction.

Ethics Committee Approval: This study was approved by the Institutional Ethics Committee.

Conflict of Interest: No conflict of interest was declared by the authors.

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