Coronary artery dimensions, anatomic findings, and distributions of Southern Turkey

TÜRKİYE'NİN GÜNEYİNDE KORONER ARTER ÇAPLARI, ANATOMİK BULGULARI VE DAĞILIMLARI

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ABSTRACT

Objective: Major coronary artery (CA) diameters, including those of the left main coronary artery (LMCA) are important predictors of the success of revascularization therapies. In the international literature, there are some studies regarding angiographic CA findings in various populations. Our aim was to assess the LMCA and major CA diameters with Quantitative Coronary Analysis (QCA) software, and to report their distributions of East Mediterranean Turkish population.

Materials and Methods: In 2016, 1139 patients who had normal CA were retrospectively included. Angiographic views were evaluated and CA diameters were measured using QCA.

Results: There were 528 women (46.4%), and 611 men (53.6%) in our study group. The mean age was 57.3±11.4 years. Hypertension frequency was 46.3% (527 patients), and the frequency of diabetes mellitus was 12.2% (139 patients). There were 497 smoking patients (43.6%). The intermediate artery was seen in 183 (16.1%) patients. There were 106 (9.3%) rudimentary right CAs, 56 (4.9%) rudimentary circumflex arteries, and 1 (0.1%) rudimentary left anterior descending artery. Proximal and distal LMCA diameters and their circular areas were significantly greater in men. When coronary artery diameters were indexed to body surface area, there was no difference between genders.

Conclusion: Our work is the largest scale study regarding quantification of coronary artery diameters of East Mediterranean Turkish population. Our findings are similar to those of Caucasians in general. We believe that the international literature will become richer with studies containing information regarding proximal and distal diameters, lengths, and areas of LMCA in various populations

Keywords: coronary artery, diameter, distribution, quantitative coronary analysis

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ÖZ

Amaç: Sol ana koroner arter (SAKA) başta olmak üzere majör koroner arterlerin çapları, yapılacak revaskülarizasyon tedavilerinin başarısı için önemli bir öngördürücüdür. Uluslararası literatüre bakıldığında çeşitli popülasyonlarda koroner arterlerin anjiyografik bulgularına dair yayınlar görülmektedir. Amacımız Türkiye'nin Doğu Akdeniz bölgesindeki bir toplulukta SAKA ve majör epikardiyal arterlerin çaplarını "Quantitative Coronary Analysis" (QCA) yazılımı ile incelemek, koroner anjiyografik bulguları ve dağılımlarını ortaya koymaktı.

Gereç ve Yöntem: 2016 yılında koroner arterleri normal saptanan 1139 hasta retrospektif olarak çalışmaya alındı. Hastaların anjiyografi görüntüleri incelendi ve QCA yazılımı aracılığıyla koroner arter çapları değerlendirildi.

Bulgular: Çalışma grubumuzda 528 kadın (%46,4), 611 erkek (%53,6) yer alıyordu. Ortalama yaş 57,3±11,4 yıl idi. Hipertansiyon sıklığı %46,3 (527 hasta) ve diyabetes mellitus sıklığı %12,2 idi (139 hasta). Sigara içen hasta sayısı 497 idi (%43,6). İntermedier arter 183 hastada görüldü (%16,1). Az gelişmiş sağ koroner arter 106 (%9,3), az gelişmiş sirkumfleks arter 56 (%4,9) ve az gelişmiş sol ön inen arter 1 (%0,1) hastada saptandı. Proksimal ve distal SAKA çapı ve alanı erkeklerde anlamlı olarak daha fazlaydı. Vücut yüzey alanına göre endekslendiğinde bu farkın ortadan kalktığı saptandı.

Sonuç: Çalışmamız Türkiye'nin Doğu Akdeniz bölgesinde koroner arter çaplarının incelenmesine yönelik en geniş kapsamlı çalışmadır. Bulgularımız genel olarak beyaz ırk verilerine benzerdir. Çeşitli popülasyonlara ait SAKA proksimal, distal çapları, uzunluğu ve alanına ilişkin verileri içeren yayınlar ile uluslararası literatürün daha da zenginleşeceğine inanmaktayız.

Anahtar Sözcükler: Koroner arter, çap, dağılım, kantitatif koroner analiz

Cardiac catheterization has been used to evaluate coronary arteries since described by Sones in the late 1960s. [1] In subsequent years, both angiographic evaluation and catheter-based interventions for treatment of coronary arteries have become common procedures. Despite technological advances in imaging devices, basic coronary angiography interpretation remains dependent on visual estimation. Interpretation of coronary artery dimension and degree of stenosis is performed visually worldwide. Nevertheless, visual lesion estimation can be wrong most of the time. Variable results can be reported with different operators or with the same operator's interpretations at different times. In the late 1970s, quantitative coronary analysis (QCA) software began to be utilized by physicians in order to prevent these mistakes. [2] QCA is a fully- or semi-automatic computerized evaluation method based on edge detection of radio contrast-filled coronary arteries. It provides information regarding coronary artery dimension, reference diameter of the vessel planned for intervention, lesion length and degree of stenosis, and it is an easily applicable, repeatable, and fairly reliable method of analysis.

Knowing the normal values of a population's coronary artery anatomy is an important issue for physicians who provide health services to that population. The dimensions of the major coronary arteries, particularly the left main coronary artery (LMCA), are important predictors of the success of revascularization therapies. [3] Coronary artery dimensions are related to age, gender, anatomic variations, left ventricle dimensions and mass, and body mass index (BMI) [4]. Some studies regarding angiographic and anatomic findings of coronary arteries in various populations can be seen in the international literature. [3, 5] However, there is limited information in the Turkish literature. [6, 7] Our aim was to evaluate the LMCA and major coronary artery dimensions by QCA, and to determine angiographic findings and distributions.

MATERIALS AND METHODS

1139 patients with normal coronary arteries who have been recruited from our outpatient unit and

underwent elective coronary angiography in 2016 were enrolled in our study. Patients with acute coronary syndrome and those treated with primary or elective percutaneous coronary angioplasty were excluded. Age, gender, weight, height, and demographic variables were recorded from patient files. Patients with left ventricle dilatation or hypertrophy were also excluded from the study. BMI and body surface area (BSA) were calculated. Local Ethics Committee of Çukurova University approved the study at 2 March 2018. The decision number was 49.

Coronary angiograms were performed with femoral access and 6-Fr Judkins or Amplatz catheters. LMCA and major epicardial coronary arteries were evaluated using standard views. Operators paid took care to fill coronary arteries with sufficient radiocontrast medium to provide better results on QCA. Patients with inadequate radiocontrast agent injection were not included. In an ideal view, mean 7–8 ml contrast agent for the left coronary system and mean 4–5 ml contrast agent for the right coronary system were used. A low-osmolality, non-ionic contrast agent (iohexol, 350 mg I/ml) was used in coronary angiograms. Patients who did not have suitable views of LMCA and proximal coronary artery segments for QCA evaluation were not included in the study. Anatomic findings of coronary arteries were recorded. Diagonal and obtuse marginal branches with > 2 mm diameter were accepted as large side branches. Coronary diameters were evaluated using QCA software (Axiom Artis version VD11C; Siemens AG, Munich, Germany) installed on an angiography device (Figure 1, Panels A–D and Figure 2). The diameters and lengths of the proximal and distal LMCA were measured in the right anterior oblique caudal view. The left anterior descending artery (LAD) proximal diameter was measured in the right anterior oblique cranial view. The circumflex artery proximal diameter was measured in the right anterior oblique caudal view. The proximal right coronary artery (RCA) was measured in the left anterior oblique view. View angles were modified if there was a need according to the patient's anatomy. Attention was paid to avoid overlapping the coronary artery segments of interest. Measurements of proximal LAD, circumflex, and RCA were performed from ostial segments of the arteries defined as the initial 5 mm of the corresponding artery.
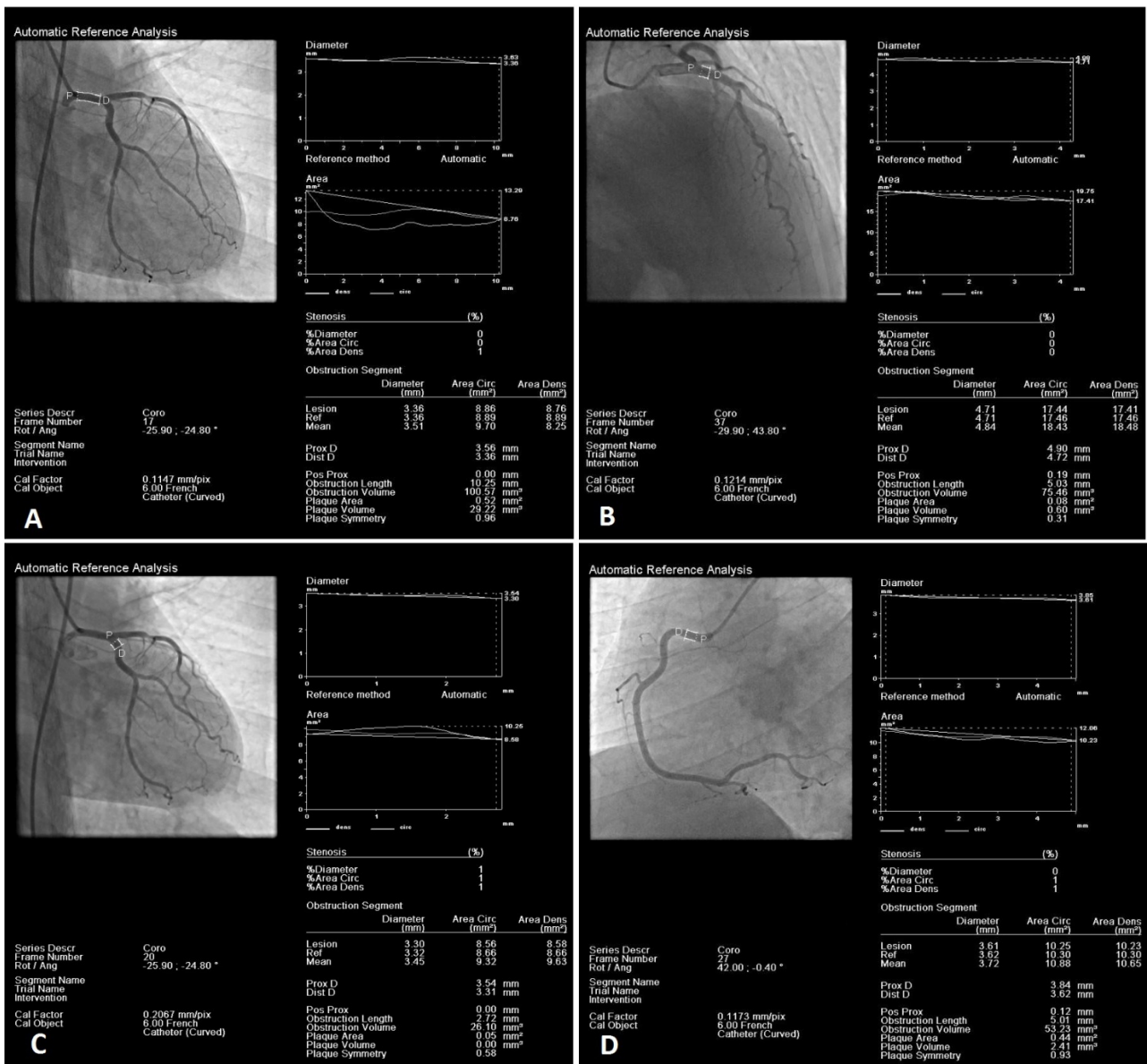
Figure 1: Panel A: QCA analysis of left main coronary artery, Panel B: QCA analysis of left anterior descending coronary artery, Panel C: QCA analysis of circumflex artery, Panel D: QCA analysis of right coronary artery
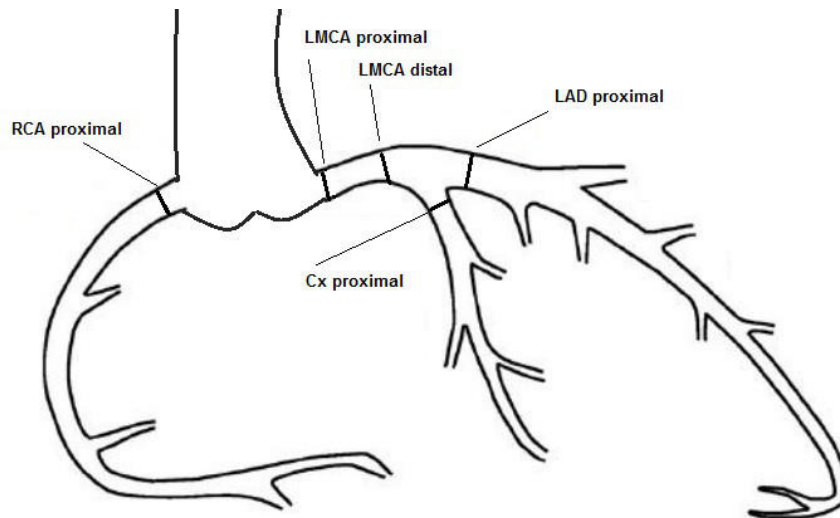
Figure 2: Demonstration of analyzed coronary artery segments by QCA

Abbreviations: LMCA: Left main coronary artery, LAD: Left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery

Statistical Analysis

Quantitative variables were expressed as mean ± standard deviation. Qualitative variables were expressed as numbers and percentages. The Kolmogorov-Smirnov test was used to determine whether continuous variables had normal distribution or not. Normally distributed continuous variables were compared using the independent samples T test, and non-normally distributed variables were compared using the Mann-Whitney U Test. Statistical analyses were performed using SPSS 22.0 software (SPSS Inc. Chicago, IL, ABD). A p value < 0.05 was considered statistically significant.

RESULTS

Demographic information is displayed in Table 1. No LMCA was present in 81 (7.1%) patients. The intermediate artery was seen in 183 (16.1%) patients. There were 106 (9.3%) rudimentary RCAs, 56 (4.9%) rudimentary circumflex arteries, and one (0.1%) rudimentary LAD artery. A conus artery originated from the RCA in 957 (84.0%) patients, and from a separate ostium in 182 (16.0%) patients. RCA and circumflex arteries were dominant in 693 (60.8%) and 314 (27.6%) patients, respectively. Co-dominancy was seen in 132 (11.6%) patients. There were 1.92 ± 0.75 and 1.82 ± 0.82 large diagonal and obtuse marginal branches, respectively. Proximal and distal LMCA diameter and LMCA circular areas were significantly higher in males (p = 0.039, p < 0.001, and p = 0.012, respectively).   LMCA length, proximal segments of the LAD, circumflex, and RCA were similar (Table 2). When indexed to BSA, there were no differences in coronary artery diameters between men and women (Table 3).

Table 1. Demographic information of patients

	Subjects (n=1139)
Age	57.3±11.4
Male gender (n, %)	611 (%53.6)
Hypertension (n, %)	527 (%46.3)
Diabetes mellitus (n, %)	139 (%12.2)
Smoking (n, %)	497 (%43.6)
Hyperlipidemia (n, %)	127 (%11.2)
Family history of coronary artery disease (n, %)	150 (%11.2)
Body mass index (kg/m^2)	28.25±4.56
Body surface area (m^2)	1.88±0.13

Table 2. Coronary artery dimensions of patients

	Male (n=611)	Female (n=528)	p value
Proximal LMCA (mm)	4.86±1.07	4.74±0.93	0.039
Distal LMCA (mm)	4.64±1.03	4.44±0.85	<0.001
LMCA length (mm)	7.72±3.93	7.72±3.36	0.992
LMCA circular area (mm^2)	17.81±7.83	16.68±6.49	0.012
Proximal LAD (mm)	3.52±0.73	3.46±0.65	0.167
Proximal circumflex artery (mm)	3.34±0.75	3.31±0.69	0.454
Proximal RCA (mm)	3.26±0.79	3.17±0.73	0.610
Dominant RCA (mm)	3.45±0.74	3.36±0.71	0.115
Dominant circumflex artery (mm)	3.55±0.77	3.58±0.68	0.764

Abbreviations: LMCA: Left main coronary artery, LAD: Left anterior descending artery, RCA: Right coronary artery

Table 3. Coronary artery diameters indexed to body surface area (mm/m^2)

	Male (n=611)	Female (n=528)	p value
Proximal LMCA	2.57±0.59	2.54±0.52	0.403
Distal LMCA	2.45±0.57	2.38±0.47	0.031
Proximal LAD	1.86±0.41	1.86±0.37	0.960
Proximal circumflex artery	1.76±0.41	1.77±0.39	0.662
Proximal RCA	1.72±0.44	1.70±0.41	0.420

Abbreviations: LMCA: Left main coronary artery, LAD: Left anterior descending artery, RCA: Right coronary artery

DISCUSSION

Coronary artery disease is one of the leading causes of death worldwide. [8] Coronary artery diameter is an important predictor of the success of percutaneous coronary intervention and by-pass graft surgery. [3, 9] The success rates of interventional treatments are higher for large coronary artery diameters. Acute or sub-acute stent thrombosis frequency was higher in vessel diameters under 2.5 mm. [10] Kürüm et al. [11] reported that small epicardial artery size might be a risk factor for development of atherosclerosis. Knowing the normal values of a population's coronary artery anatomy for a physician who provides health services to that population enhances the physician's approaches. Simultaneously, this physician will become more informed regarding the facts that will affect the results of the procedure. Frequently, operators evaluate

the coronary artery lumen diameter by QCA. Mazhar et al. [12] reported that there was a good correlation between coronary diameters measured by QCA and optical coherence tomography (OCT) methods.

Many studies reporting normal diameters of coronary arteries have been conducted in various populations starting in the 1990s. [5, 13-16] Asian, Indian,

Indo-Asian, and Pakistani patients have small coronary artery diameters according to these studies. Caucasians have larger coronary artery diameters. Authors have attributed this major difference to larger body structure and body surface area. Our findings were similar to those of Caucasian population coronary diameters in these studies (Table 4).

Table 4. Coronary artery dimensions of different populations

Population	Number	Gender	LMCA (mm)	Proximal LAD (mm)	Proximal Cx (mm)	Proximal RCA (mm)
Turkish (our study)	611	Male	4.86±1.07	3.52±0.73	3.34±0.75	3.26±0.79
	528	Female	4.74±0.93	3.46±0.65	3.31±0.69	3.17±0.73
USA (5)	60	Male	4.5±0.5	3.6±0.5	3.4±0.5	3.9±0.6
	10	Female	3.9±0.4	3.2±0.5	2.9±0.6	3.3±0.6
Caucasian (13)	53	Male	4.5±0.9	3.5±0.7	3.5±0.8	3.8±0.8
Asian (13)	53	Male	4.6±0.9	3.5±0.8	3.4±0.8	3.5±0.8
Indian (14)	61	Male	3.72±0.6	2.85±0.6	2.82±0.6	2.75±0.6
	33	Female	3.40±0.6	2.72±0.5	2.68±0.6	2.55±0.6
Pakistani (16)	220	-	4.28±0.82	3.22±0.74	3.02±0.75	3.08±0.78

Abbreviations: LMCA: Left main coronary artery, LAD: Left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery, USA: United States of America

Women's coronary artery diameters are smaller than those of men. Raut et al. [3] reported that men had larger coronary arteries than women in a study including 229 subjects. However, they also reported that there were no differences between men and women when coronary artery diameter was indexed to body surface area. We observed that proximal and distal LMCA diameter and its circular area were significantly greater in men. When coronary artery diameters were indexed to body surface area, there were no differences between genders.

Coronary artery disease revascularization success rates were lower and complication rates were higher in women [17]. This negative situation can be partially attributed to smaller coronary artery diameter in women. Despite the fact that there appears to be no difference in body surface area indexed diameters between men and women, the diameter of the coronary artery is substantially important predictor for revascularization treatments. Mid-range stenosis in a small artery will cause more hemodynamic problems when compared to larger arteries [18].

The most important aspect of our study is that it is the largest scale study that included information regarding proximal diameters of normal coronary arteries in the Turkish and international literature. Furthermore, proximal and distal diameter, length, and mean circular area of LMCA were first described in our study.

Limitations of the study

Our study had a retrospective design and does not represent a "normal" population. It would not be ethical to include healthy adults in a study such as this. We did not correlate our measurements with intravascular ultrasound. This is an important limitation. Another limitation was that we only recorded proximal segments of the coronary artery tree. Finally, the data in this paper represents only an East Mediterranean territory of Turkey. It is a single centered study and it does not cover the whole Turkish population.

Our work is the largest scale study regarding quantification of coronary artery diameters of East Mediterranean Turkish population. Our findings are similar to those of Caucasian people in general. We believe that the international literature will become richer with

studies containing information regarding proximal and distal diameter, length, and area of LMCA in various populations.

Conflict of Interest

None declared

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