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Screening of coronary artery anomalies in 11,707 patients reveals that the radial approach is safe for cannulating coronary anomalies

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Abstract. – OBJECTIVE: This study evaluated the transradial approach for its ability to diagnose coronary artery anomalies, its requirement for catheter usage, the number of images obtained and fluoroscopy time required.

PATIENTS AND METHODS: A total of 11,707 patients' coronary angiograph reports from January 2009 to January 2016 were evaluated with 179 patients identified as having coronary artery anomalies. Subsequent analyses compared patients' access sites with multiple angiographic parameters, including the number of images obtained, catheters used, and the fluoroscopy time required.

RESULTS: The frequency of coronary artery anomalies identified by angiographies was 0.015%. Coronary anomalies were detected by transradial access (TRA) in 133 patients and by transfemoral access (TFA) in 46 patients. The most common anomaly was in the right coronary artery originating from the left sinus Valsalva (71 patients; 39.2%). The fluoroscopy times required and the number of catheters used was similar between the TRA and TFA groups (p = 0.887 and 0.302, respectively) while the number of images obtained during coronary angiographies was higher in the TFA group (p = 0.021).

CONCLUSIONS: TRA is safe and effective for cannulation and the diagnosis of congenital coronary artery anomalies.

Key Words:
Coronary artery anomaly, Coronary angiography, Radial artery, Femoral artery, Radial approach, Radial access.

Introduction

The majority of patients with coronary artery anomalies are believed to be asymptomatic although patients may experience chest pain, severe arrhythmias, myocardial infarction, syncope, or sudden cardiac death (SCD). Unfortunately, SCD is often the first symptom in young competitive athletes, where congenital coronary artery anomalies are the second most frequent cause of SCD[1,2]. The exact prevalence of coronary artery anomalies is not known; however, estimates based on various definitions and imaging methods suggest a range of 0.21-5.79%[3].

The selection of diagnostic and guiding catheters is a major challenge for conventional transfemoral access (TFA) angiographies. Coronary artery anomalies increase the procedural and fluoroscopy times, as well as the number of catheters used and images obtained[4]. Compared to TFA, transradial access (TRA) is associated with a reduced risk of bleeding and vascular complications, lower hospital mortality, and higher patient satisfaction[5]. Thus, the use of TRA is increasing worldwide. This retrospective study evaluated the ability of TRA to diagnose coronary artery anomalies, as well as the number of catheters the method required, the number of images obtained, and the fluoroscopy time required.

Patients and Methods

Patients and Procedures

A total of 11,707 patients who underwent angiography between January 2009 and January 2016 at the Tertiary Cardiac Center at Mevlana (Rumi) University Private Hospital were assessed. Patients undergoing emergency and elective coronary angiographies for the diagnosis of coronary artery disease, or evaluation before valve surgery, were enrolled. Patients with complex congenital heart disease and muscular bridges were excluded. Of the 11,707 patients, 179 had coronary artery anomalies.

Three experienced interventional cardiologists reevaluated the angiographic images of the coronary artery anomalies to determine the type of

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anomaly present. Experienced cardiologists also performed coronary angiographies using a Siemens Axiom Artis dBA (Siemens Healthcare, Forchheim, Germany) catheterization system by TRA and TFA. Anomalies were subsequently divided into seven subgroups: (A) anomalies with a coronary origin (aortic), (B) anomalies with a coronary origin (nonaortic), (C) interarterial communication, (D) coronary artery fistula, (E) multiple anomalies, (F) coronary atresia, and (G) aneurysms (saccular) (Table I). Cardiovascular risk factors and symptoms were obtained from medical records and the Institutional Ethics Committee approved the study protocol.

Statistical Analysis

Continuous variables were compared using the Student's *t*-test or Mann-Whitney U-test and are reported as means ± SDs. Percentages were used for categorical variables, which were compared using the chi-square test or Fisher's exact test. A *p*-value < 0.05 was considered statistically significant. All statistical data were analyzed using SPSS software (version 17.0, SPSS Inc., Chicago, IL, USA).

Results

Of the 11,707 patients, TRA angiographies were performed on 7,020 patients while TFA angiographies were performed on 4,687 patients. A total of 179 patients had coronary artery anomalies (0.015%) (Figure 1). The frequencies and percentages of coronary anomalies are shown in Table I. Considering all patients, anomalies in the right coronary artery (RCA), originating from the left sinus Valsalva (sV) were most frequent (71 patients; 39.2%), with anomalies in the left anterior descending (LAD) artery, and circumflex (CX) originating from the separate ostia being second most frequent (37 patients; 20.4%). A

Table I. Details of coronary artery anomalies.

Type of anomaly (n=179)	Number of Patients	Frequency (%)
A) Anomalous origin of coronary artery (aortic)		
LAD-CX originating from separate ostia	37	20.4
RCA originating from the left sV	71	39.2
CX originating from right sV	11	6.1
LMCA originating from the right and posterior sV	5	2.8
All coronary arteries originating from separate ostia from the right sV	1	0.6
B) Anomalous origin of coronary artery (nonaortic)		
Pulmonary	0	0
Non-Pulmonary	7	4
CX-originating from RCA	5	2.8
RCA originating from CX	1	0.6
RCA originating from LAD	1	0.6
Septal artery originating from LMCA	0	0
C) Interarterial communication	**2**	**1.1**
D) Coronary artery fistula		
LAD-pulmonary artery	3	1.7
CX-pulmonary artery	1	0.6
RCA-pulmonary artery	4	2.2
LMCA-pulmonary artery	1	0.6
LAD-left ventricle	5	2.8
CX-left ventricle	8	4.5
RCA-right ventricle	1	0.6
E) Number anomalies		
Dual RCA	0	0
Dual LAD	11	6.1
F) Coronary atresia	**1**	**0.6**
G) Aneurysms (saccular)	**10**	**5.6**
Total	179	100

LMCA: left main coronary artery; LAD: left anterior descending, CX: circumflex artery RCA: right coronary artery; sV: sinus of Valsalva.

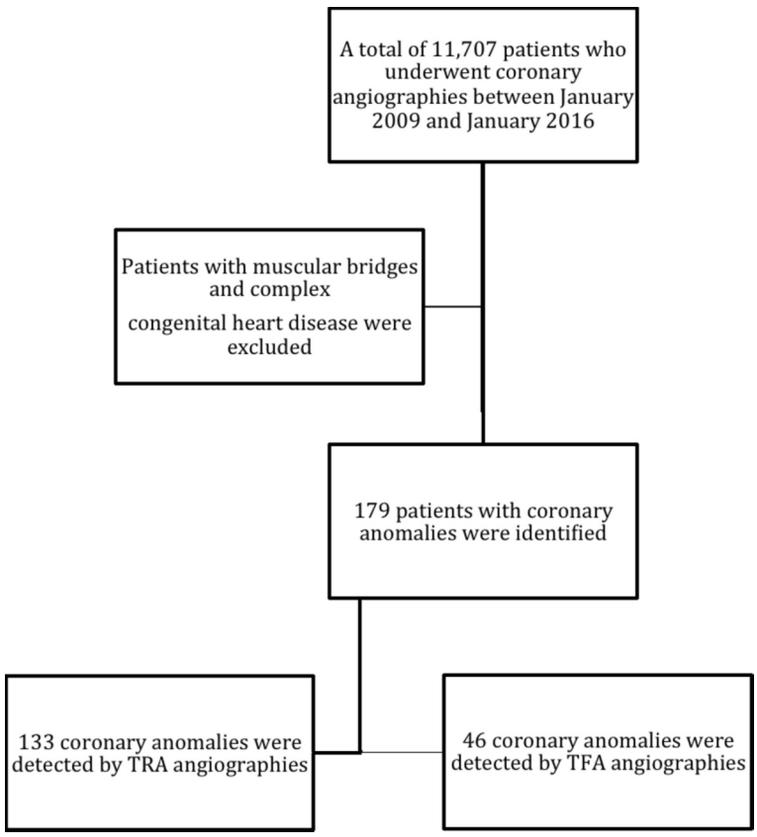

Figure 1. Study flow diagram.

coronary fistula between the CX and left ventricle was the most frequent fistula type (8 patients). Dual LAD and RCA anomalies were observed in all 179 patients.

Angiographies were performed by TRA in 133 patients (74.3%) and TFA in 46 patients (25.7%). The mean patient age in the TRA group was 61.32±10.48 years old, while that of the TFA group was 66.76±10.48 years old ($p = 0.04$). No significant differences in the prevalences of hypertension, diabetes mellitus, hyperlipidemia, smoking, or family history were observed between patients in the two groups, while that rate of coronary artery disease was higher among patients in the TFA group ($p = 0.023$). In addition, typical and atypical anginas were significantly more prevalent among the TFA group ($p < 0.01$ and $p < 0.01$), as were the number of images obtained during the coronary angiographies ($p = 0.021$). The numbers of patients with acute coronary syndromes were similar between the two groups ($p = 0.117$), as were fluoroscopy times and the numbers of patients requiring more than two catheters ($p = 0.887$ and 0.302, respectively). Notably, the access site was changed from TRA to TFA in a single patient with acute coronary syndrome and all patients with difficult ostial cannulation of an anomalous RCA originating from the left sV (Table II).

Patients were divided into two groups according to the number of catheters used during the coronary angiography. Shown in Table III are the demographic data, type of complaints, access sites, number of images, and fluoroscopy times required for each patient. Both groups had similar baseline characteristics, including age, sex, hypertension, diabetes mellitus, hyperlipidemia, smoking, family history, and the presence of coronary artery disease. More than two catheters were used in 24 patients belonging to the TFA group (30%) and 56 patients in the TRA group (70%) ($p = 0.302$). Atypical anginas were more common in the TFA group, while acute coronary syndromes were significantly more common in the TRA group ($p = 0.014$ and $p = 0.019$, respectively). The numbers of patients with typical anginas were

Table II. Comparison of the access site according the demographic data, number of images obtained, number of catheters used, and fluoroscopy time required (n=179).

	Access Site			
	Femoral (n=46)	Radial (n=133)	All	*p*-value[b]
Age (years)	66.76±12.22	61.32±10.48	62.72±11.18	0.04
Sex [n (%)]				
Female	19 (41.3)	55 (41.49	74 (41.3)	0.568
Male	27 (58.7)	78 (58.6)	105 (58.7)	
Hypertension [n (%)]	23 (50.0)	53 (39.8)	76 (42.5)	0.299
Diabetes mellitus [n (%)]	7 (15.2)	27 (20.3)	34 (19)	0.519
Hyperlipidemia [n (%)]	24 (52.2)	56 (41.1)	80 (44.7)	0.302
Smoking [n (%)]	18 (39.1)	62 (46.6)	80 (44.7)	0.396
Family historya [n (%)]	8 (17.4)	42 (31.6)	50 (27.9)	0.086
Coronary artery disease [n (%)]	35 (76.1)	76 (57.1)	111 (63.2)	0.023
Type of complaint [n (%)]				
Typical angina	15 (32.6)	50 (37.6)	65 (36.3)	<0.01
Atypical angina	13 (28.3)	74 (55.6)	87 (48.6)	<0.01
Acute coronary syndrome	17 (37.0)	9 (6.8)	26 (14.5)	0.117
Syncope	1 (2.2)	0 (0)	1 (0.6)	-
Number of images	7.22±0.987	6.83±0.892	6.93±0.930	0.021
Fluoroscopy time	10.60±2.26	10.55±2.28	10.56±2.27	0.887
Number of catheters (more than two catheters)	24	56	-	0.302
Access site change [n (%)]	0 (0)	1 (1.2)		0.743

[*]Data not referred to the whole body of studies, because not always available. NA: Not available;

similar between the groups ($p = 0.385$). Considering patients who required more than two catheters, the numbers of images obtained (6.39±0.63 *vs.* 7.59±0.80) and the fluoroscopy times required (9.66±1.93 *vs.* 11.67±2.17) were significantly higher in the TFA group ($p < 0.001$ and $p < 0.001$, respectively). Among patients requiring more than two catheters, the access site was changed from TRA to TFA in those with difficult ostial cannulation of an anomalous RCA originating from the left sV.

An RCA anomaly originating from the left sV was the most frequent anomaly in this study. Table IV shows the demographic data, access site changes, number of images obtained, number of catheters used, and fluoroscopy times required based on access site. Age, sex, hypertension, diabetes mellitus, hyperlipidemia, smoking, family history, presence of coronary artery disease, access site change, number of images, number of catheters, and fluoroscopy times required were similar between patients in the TFA and TRA groups. Atypical anginas were more prevalent in the TFA group ($p < 0.001$), while the rates of typical anginas and acute coronary syndromes were similar between the groups ($p = 0.221$ and $p = 0.179$, respectively).

Discussion

Coronary arteries supply blood flow from the aorta to cardiac tissue. While coronary artery anatomies vary between individuals, the normal anatomy is still debated. Therefore, the exact prevalence of congenital coronary anomalies remains unknown in the general population as the diagnostic methods and criteria vary. According to a recent review by Pérez-Pomares et al[3], coronary anomalies are present in 0.21-5.79% of adults. In our retrospective study, coronary anomalies were observed in 0.015% of patients, less than that observed in related studies[6-8].

In the current study the most common anomaly was RCA originating from the left sV, followed by LAD-CX anomalies originating from the separate ostia. Yamanaka and Hobbs[8] identified 1,686 anomalies from 126,595 patients and found that that LAD-CX originating from the separate ostia was most common. Another study that screened 25,368 patients by coronary angiography also reported that LAD-CX anomalies originating from the separate ostia were the most common, which did not complicate cannulation of the LAD and CX ostium[4]. Notably, some investigators do not consider LAD-CX anomalies that originate from

Table III. Comparison of the number of catheters used according to the demographic data and access site (n=179).

Number of catheters used during coronary angiography			
	Two catheters (n=99)	More than two catheters (n=80)	*p*-value[b]
Age (years)	62.33±10.79	63.20±11.69	0.608
Sex [n (%)]			
Female	45 (45.5)	29 (36.2)	0.138
Male	54 (54.5)	51 (63.8)	0.226
Hypertension [n (%)]	41 (41.4)	35 (43.8)	0.435
Diabetes mellitus [n (%)]	16 (16.2)	18 (22.5)	0.339
Hyperlipidemia [n (%)]	38 (38.4)	42 (52.5)	0.070
Smoking [n (%)]	41 (51.2)	39 (48.8)	0.326
Family history [n (%)]	26 (26.3)	24 (30.0)	0.349
Coronary artery disease [n (%)]	56 (56.6)	55 (68.8)	0.065
Type of complaint [n (%)]			
Typical angina	36 (36.4)	29 (36.2)	0.385
Atypical angina	55 (55.6)	32 (40.0)	0.014
Acute coronary syndrome	7 (7.1)	19 (23.8)	0.019
Syncope	1 (1)	0 (0)	-
Access site [n (%)]			
Femoral	22 (22.2)	24 (30)	0.236
Radial	77 (77.8)	56 (70.0)	0.302
Access site Change [n (%)]	0 (0)	1 (1.2)	0.447
Number of images	6.39±0.63	7.59±0.80	<0.01
Fluoroscopy time	9.66±1.93	11.67±2.17	<0.01

[a]Family history of coronary artery disease. [b]Bolded data are statistically significant.

Table IV. Comparison of access sites in patients with RCA originating from a left sV anomaly (n=71).

RCA originating from left SV			
	Two catheters (n=99)	More than two catheters (n=80)	*p*-value[b]
Age (years)	65.81±13.39	60.07±9.33	0.037
Sex [n (%)]			
Female	12 (46.2)	16 (35.6)	0.530
Male	14 (53.8)	29 (64.4)	0.453
Hypertension [n (%)]	15 (57.7)	16 (35.6)	0.086
Diabetes mellitus [n (%)]	3 (11.5)	12 (26.7)	0.227
Hyperlipidemia [n (%)]	13 (50.0)	28 (62.2)	0.070
Smoking [n (%)]	10 (38.5)	14 (53.3)	0.324
Family history [n (%)]	5 (19.2)	16 (35.6)	0.183
Coronary artery disease [n (%)]	18 (69.2)	25 (55.6)	0.318
Type of admission complaint [n (%)]			
Typical angina	9 (34.6)	15 (33.3)	0.221
Atypical angina	7 (26.9	25 (55.6)	<0.001
Acute coronary syndrome	10 (38.59	5 (11.1)	0.197
Syncope	0 (0)	0	-
Access site change [n (%)]	0 (0)	1 (1.2)	0.447
Number of catheters	3.04±0.66	3.13±0.72	0.586
Number of images	7.62±0.98	7.42±0.89	0.413
Fluoroscopy time	11.64±2.20	11.63±2.19	0.988

[a]Family history of coronary artery disease. [b]Bolded data are statistically significant.

the separate ostia as true anomalies; therefore, these may be underreported.

Coronary fistulas between the ventricle and pulmonary arteries were the third most common anomaly in this study. Coronary artery fistulas are rare, and are generally observed in 0.05-0.2% of coronary angiograms[9]. Most coronary artery fistulas are clinically insignificant and only a single patient in this study had a large fistula due to ischemia, which was treated by a percutaneous coil. Also considered in this study was interatrial communication, coronary artery fistulas, the number of coronary artery anomalies, coronary atresia, and aneurysms; however, none of those factors affected the required fluoroscopy time, the mean number of catheters used, or the mean number of images obtained during angiographies[4].

The number of coronary artery anomalies as a factor for assessments is controversial. Cases of dual RCA are common in Turkey, which some investigators have suggested is merely due to a split of the RCA[10]. Dual LAD anomalies were also common in this study; however, those were generally benign and asymptomatic. This anomaly did not complicate cannulation of the LAD ostium[11].

Visualizing coronary anomalies is particularly challenging when using conventional TFA, particularly when coronary arteries originate from different sV[4,12]. Consequently, the fluoroscopy time required, the number of catheters used, and the number of images obtained are higher for this type of anomaly, compared to all others[4]. TRA offers many benefits over TFA, including less bleeding and vascular complications, decreased time to ambulation, shorter durations of hospital stay, lower healthcare costs, improved prognosis, and increased patient satisfaction[13,14]. In 2008, our hospital began using TRA, which is now common practice.

Comparing baseline data for the TRA and TFA groups in this study, coronary artery disease and acute coronary syndromes were statistically higher in the TFA group. This is because our initial cases using TRA did not include patients with acute coronary syndromes or patients at high risk for coronary artery disease. In those cases, TFA was used. Upon widespread implementation of TRA at our hospital, TFA was used only for patients with insufficient palmar vascular supply, acute coronary syndromes with hypotension, who were >85 years old, or those undergoing hemodialysis or who had previously been treated with radial artery for bypass grafting. In those cases, no differences were observed between the number of images obtained, number of catheters used, or fluoroscopy time required when TRA or TFA was used. In a single case in this study the access site was changed from TRA to TFA for a patient with acute inferior myocardial infarction due to problematic cannulation and insufficient support for primary percutaneous intervention.

The primary limitation of this study was that coronary anomalies were screened from angiography reports and images, and the reporting of coronary anomalies may differ between cardiologists. A second limitation is that the angiography reports screened in this study were based on the date that TRA was implemented at our hospital. Reliable data before January 2009 were not obtained and we only used coronary anomalies with TFA after this time.

Conclusions

To the best of our knowledge, this is the first study on the use of TRA for the diagnosis of coronary anomalies. Based on the data evaluated in this study, TRA is safe and effective for the diagnosis and cannulation of congenital coronary artery anomalies.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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