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Right and left coronary artery angiography with single Judkins left catheter via right radial artery

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ABSTRACT

Objectives: The aim of this study was to assess the safety and efficacy of single Judkins left (JL) catheter to view right and left coronary artery in right transradial coronary angiography.

Methods: A total of 266 patients underwent coronary angiography from the right radial artery were studied prospectively. Patients with ad-hoc percutaneous coronary intervention (PCI), peripheral angiography, ventriculography or aortography procedures (67 patients) were excluded from the study. Coronary angiography was performed with the JL catheter as single catheter group in 171 of the remaining 199 patients, and with the Judkins right and left catheters as the control group in the other 28 patients. Complications, procedure success, procedure time and fluoroscopy time were evaluated between the two groups.

Results: Procedure success were 93% (159/171) in patients with a single catheter group and 96.4% (27/28) in patients with two catheter (Judkins right and left) group (control group) ($p = 0.49$). Complications (spasm) are the same between the two groups (8 of 171 [4.7%] patients in study group and 1 of 28 [3.6%] patients in control group, $p = 0.79$). Fluroscopy time in single JL catheter group was significantly higher (6.20 ± 4.97 min vs 3.76 ± 2.78 min, $p = 0.01$).

Conclusions: Single JL catheter using to view right and left coronary artery in right transradial coronary angiography was safe and effective. In our study, the success rate of getting left and right coronary artery images with a single JL catheter as high as 93%. However, insisting on imaging with a single catheter extends the duration of fluoroscopy time.

Keywords: Right radial angiography, Judkins left catheter, fluoroscopy time, complication

Cardiac catheterization via the radial artery was first applied in 1989 [1]. Later, it started to be used for coronary interventional procedures [2]. Intervention via the radial artery has started to be preferred more because it provides early movement of the patient, fewer bleeding complications, and higher patient comfort [3]. Current guidelines recommend radial angiography instead of femoral angiography for coronary angiography and percutaneous coronary intervention [4]. However, the radial artery diameter is small and contains various congenital differences. In addition, the radial artery is very prone to spasm with manipulation. Again, repeated catheter insertion through the radial artery increases radial spasm. In addition, repeated catheter insertion due to tortuosity in the brachial, subclavian and brachiocephalic arteries may increase embolic and vascular complications. In order to prevent such problems, various catheters have

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been developed to prevent repeated catheter insertion and to visualize both coronary systems (right and left systems) with a single catheter [5]. However, these catheters increase the cost of the procedure. In addition, recent studies investigating the dual versus single catheter strategy for transradial coronary angiography have produced inconsistent results [6, 7], and the double-catheter strategy still represents the standard approach among approximately 40% of operators [8].

In this study, we evaluated the feasibility and safety of imaging the right and left coronary systems with right radial access and single Judkins left (JL) catheter.

METHODS

Study Population

The ethics committee of Bursa Yüksek İhtisas Training and Research Hospital was approved for the study. A total of 266 consecutive patients aged 18 years and older who underwent coronary angiography via the right radial artery were included in the study. Patients who continued percutaneous coronary intervention after coronary angiography, underwent peripheral angiography, or had an imaging other than coronary imaging were excluded from the study (Fig. 1). Of the remaining 199 patients, 171 were included in the single JL catheter group, while 28 were included in the standard right and JL catheter group. Basal and procedural characteristics of the patients were recorded.

Procedure

In patients with palpable right radial artery, a 7 cm, hydrophilic coated, 6F sheath was introduced with a 21G needle and a 40 cm 0.018 guidewire followed by intra-arterial application of nitroglycerine (200 mcg) and unfractioned heparin (7500 IU). In the study, JL 4 catheter was used as a single catheter for right and left coronary angiography. First, the left coronary was visualized with the JL 4 catheter, then 0.038 guide wire was advanced through the JL 4 catheter, which was

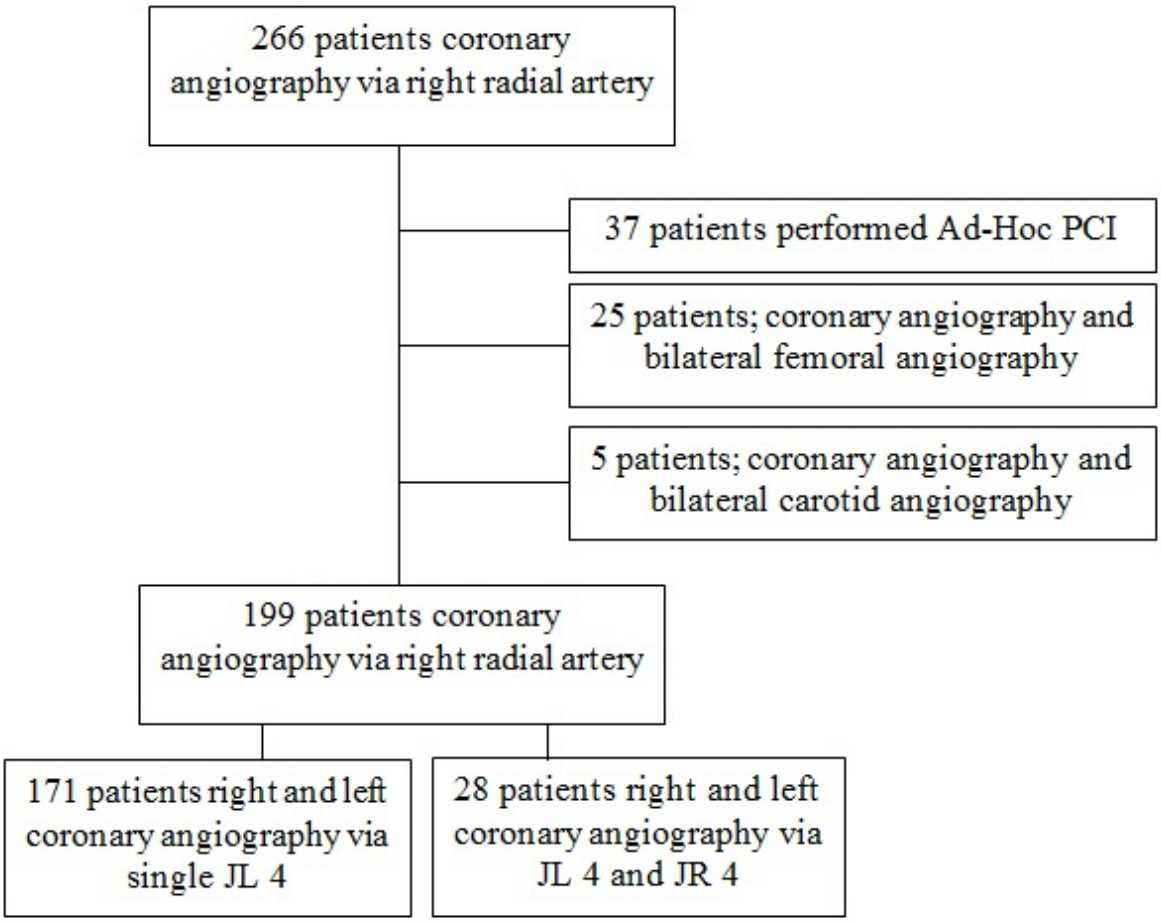

Fig. 1. Study diagram.

pulled back from the LMCA to the aorta, the tip of the JL 4 catheter was straightened, and the right coronary was seated with clockwise rotation, and the right coronary was imaged (Fig. 2). Successful imaging was defined as the JL 4 catheter seating in the right coronary ostium and obtaining clear images (Fig. 2). If the right coronary artery could not be seated with a maximum of 4 attempts, the attempt with a single catheter was considered unsuccessful and the right coronary artery was visualized with a standard JR 4 or another suitable catheter. JR 4 and JL 4 catheters were used for right and left coronary angiography with double catheters. The exchange of the two catheters was made over the 0.038 guidewire, which was sent through the JL 4 catheter to the ascending aorta. Failure to visualize the right coronary with a standard JR 4 catheter and the need for another catheter was defined as a failure for right coronary imaging with a double catheter.

After the radial sheat was entered, imaging was performed first by entering the JL 4 catheter in both groups. The time elapsed from the radial sheath entry of the JL 4 catheter to its exit after imaging of both coronary arteries was defined as the procedure time in single catheter group and recorded. The time elapsed from the radial sheath entry of the JL 4 catheter to the JR 4 exit after imaging of both coronary arteries was defined as the procedure time in control group and recorded. The duration of fluoroscopy used during imaging of the right and left coronary arteries was recorded. The number of exposures taken to view the right and left coronaries was recorded. The amount of contrast used was recorded. The amount of radiation exposed during the procedure was recorded.

Radial spasm was demonstrated by arteriography in case of difficulty in catheter manipulation and pain in the right arm. Routine radial arteriography was not performed. After the procedure, hemostasis at the radial entry site was achieved with a compression band.

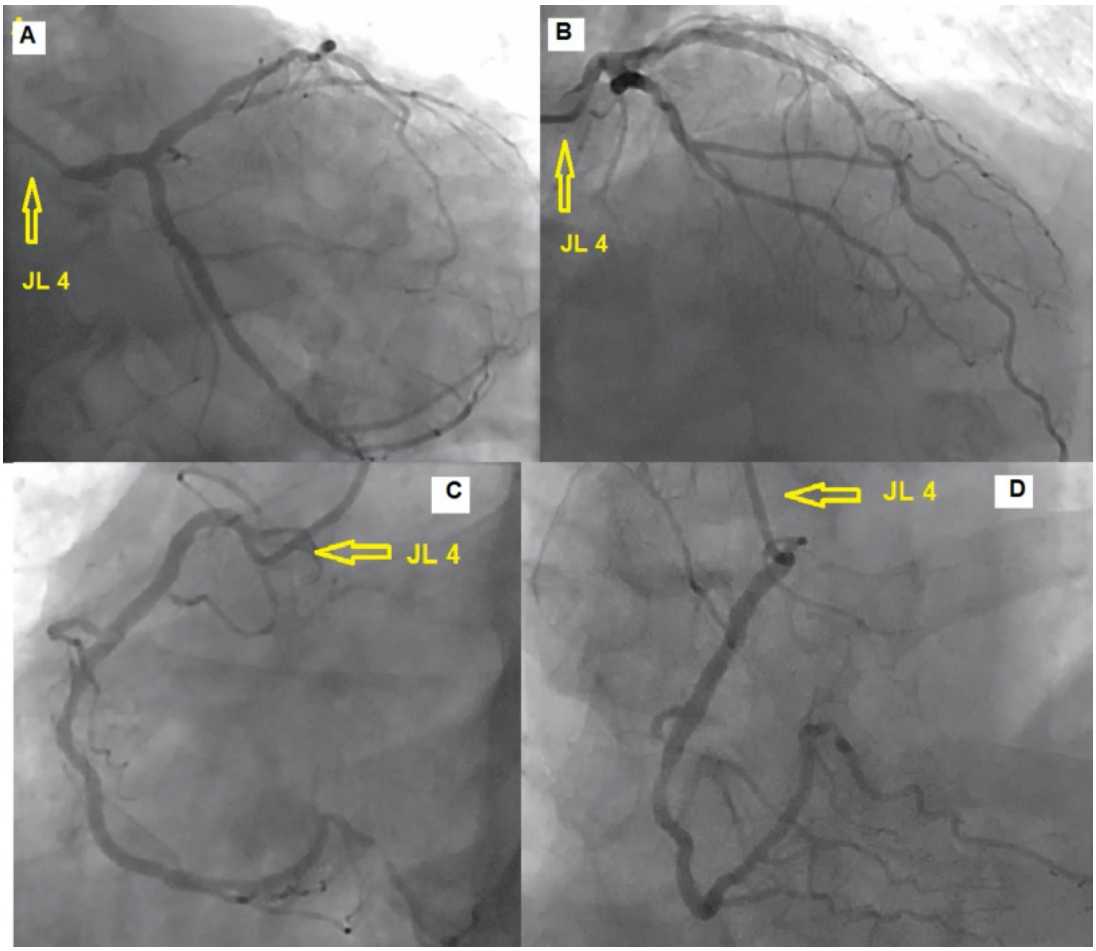

Fig. 2. A: Left system coronary angiography via JL 4 catheter, left caudal view, B: Left system coronary angiography via JL 4 catheter, right anterior oblique view. C: Right coronary angiography via JL 4 catheter, left anterior oblique view, D: Right coronary angiography via JL 4 catheter, anteroposterior cranial view.

Compression was gradually reduced 2 hours after the procedure, and the compression band was removed after bleeding control was achieved.

Coronary artery disease was defined as having stenosis of 50% or more in the coronary arteries. Coronary angiography procedures were performed by 3 different operators experienced in radial angiography.

Statistical Analysis

Statistical analysis was performed using the SPSS computer program (Statistical Package for the Social Sciences ver. 22., SPSS Inc, Chicago, Illinois, USA). Continuous variables were reported as mean ± standard deviation, and categorical variables as percentages. Student's t test was used to compare the normally distributed variables, and the Mann Whitney U test was used to compare the non-normally distributed variables. Categorical variables were compared with the Chi-square test or Fisher's exact test as appropriate. A value of $p < 0.05$ was considered significant.

RESULTS

After 67 of the 266 patients evaluated for the study were excluded due to exclusion criteria, 199 patients were included in the study. 171 patients were included in the single catheter group and 28 patients were included in the double catheter group. There was no difference between the groups in terms of demographic characteristics of the single catheter group and the two-catheter (control) group (Table 1). In the single-catheter group, 36.8% of the patients and in the double catheter group, 17.9% were female ($p = 0.06$). The groups were similar in terms of diabetes, hypertension, peripheral arterial disease and percutaneous coronary

Table 1. Demographic characteristics of the study groups

Variables	Study group (n = 171) (single JL 4)	Control group (n = 28) (JL 4 and JR 4)	*p* value
Age (years) (mean ± SD)	59.77 ± 11.11	57.64 ± 13.48	0.52
Sex			0.06
Male, n (%)	108 (63.2)	23 (82.1)	
Female, n (%)	63 (36.8)	5 (17.9)	
BMI (kg/m^2) (mean ± SD)	28.73 ± 4.51	28.26 ± 4.75	0.97
Diabetes mellitus, n (%)	38 (22.2)	6 (21.4)	0.92
Hypertension, n (%)	132 (77.2)	17 (60.7)	0.06
Peripheral artery disease, n (%)	10 (5.8)	2 (7.1)	0.79
Previous PCI, n (%)	42 (24.6)	7 (25)	0.96
Medication, n (%)			
Aspirin	137 (80.1)	19 (67.9)	0.14
ACEI	121 (70.7)	17 (60.7)	0.32
Beta blocker	103 (60.2)	14 (50)	0.30
CCB	36 (21.1)	3 (10.7)	0.20
Nitrate	26 (15.2)	3 (10.7)	0.53
Statin	76 (44.4)	9 (32.1)	0.22
SBP (mmHg) (mean ± SD)	134.77 ± 15.51	137.18 ± 22.71	0.65
DBP (mmHg) (mean ± SD)	79.32 ± 11.68	79.50 ± 7.91	0.96
HR (beats per minute) (mean ± SD)	86.82 ± 11.23	91.30 ± 12.80	0.26

JL = Judkins left, JR = Judkins right, BMI = Body mass index, PCI = Percutaneous coronary intervention, ACEI = Angiotensin converting enzyme inhibitor, CCB = Calcium channel blocker, SBP = Systolic blood pressure, DBP = Diastolic blood pressure, HR: Heart rate

intervention (PCI) history. There was no difference between the two groups in terms of drugs used by the groups, blood pressures and heart rates (Table 1).

According to the evaluation related to the procedure, an extra catheter was needed in 12 patients in the single catheter group and 1 patient in the double catheter group ($p = 0.49$) (Table 2). The number of lesioned coronary arteries, the contrast volume used, the number of imaging performed on the right and left coronary arteries, and the duration of the procedure were similar in both groups (Table 2). The fluoroscopy time of the single catheter group (6.20 ± 4.97 min) was significantly longer than the double catheter group (3.76 ± 2.78 min) ($p = 0.01$) (Table 2). Although the radiation dose exposed during the procedure was higher in the single catheter group (1089.18 ± 620.42 uGycm2) compared to the double catheter group (855.83 ± 469.46 uGycm^2), it was not significant (p = 0.23) (Table 2). Right coronary artery was visualized with the first movement of JL catheter in 70 of 171 (40.9%) study group patients. Radial spasm was similar in both groups (Table 2).

DISCUSSION

The main results of our study can be listed as follows; i) right and left systems can be safely and successfully visualized by entering through the right radial artery with a single JL catheter, ii) fluoroscopy time during imaging with a single catheter is longer than in the double catheter group, iii) radial artery spasm is similar in the single and double catheter groups.

In recent years, the radial artery has been used with increasing frequency compared to the femoral artery for coronary angiography and PCI, and it has started to replace as a standard approach in the guidelines [4]. In daily practice, the right radial artery is used more frequently because of easy access. With the standard catheters generally used for femoral angiography, intervention is made from the radial artery, which has a much lower profile. As the number of manipulations increases, the risk of complications such as spasm, bleeding and thrombosis increases [9]. For this reason, researches are continuing intensively to terminate the procedure as soon as possible and with the least number of catheter manipulations.

Numerous studies have been conducted to investigate the dual versus single catheter strategy in transradial coronary angiography [10]. The common goal of these studies was to show that a single catheter is at least as effective as a double catheter and less complications occur. Achieving the intended outcomes in a single catheter strategy will provide significant clin-

Table 2. Procedural data of the study groups

Variables	Study group (n = 171) (single JL 4)	Control group (n = 28) (JL 4 and JR 4)	*p* value
Need for additional catheter, n (%)	12 (7)	1 (3.6)	0.49
Coronary disease, n (%)			0.067
1 vessel disease	39 (22.8)	3 (10.3)	
2 vessel disease	27 (15.8)	1 (3.6)	
3 vessel disease	33 (19.3)	10 (35.7)	
Contrast volume (ml) (mean ± SD)	77.84 ± 15.76	72.42 ± 13.35	0.23
Number of right coronary image (mean ± SD)	2.15 ± 0.80	2.22 ± 0.84	0.68
Number of left coronary image (mean ± SD)	4.33 ± 1.17	4.77 ± 0.94	0.07
Procedure time (min) (mean ± SD)	9.83 ± 6.25	9.57 ± 6.26	0.87
Fluoroscopy time (min) (mean ± SD)	6.20 ± 4.97	3.76 ± 2.78	0.01
DAP (uGycm^2) (mean ± SD)	1089.18 ± 620.42	855.83 ± 469.46	0.23
Radial spasm, n (%)	8 (4.7)	1 (3.6)	0.79

DAP = Dose area product

ical and cost benefits.

Catheters with a variety of specific curves, such as Kimny (Boston Scientific, Natick, MA), Barbeau (Cordis Bridgewater, NJ), Jacky (Terumo, Sommerset, NJ), and Tiger (Terumo, Somerset, NJ) were developed for performing single catheter coronary angiography through the radial artery. In addition, many catheters have been tried as multipurpose catheters in transradial interventions [5, 6, 11, 12]. The Tiger catheter is the most well-known of these. In the study performed by Kim *et al*. [5] in 2006, a single Tiger II (Terumo Corporation, Tokyo, Japan) catheter specific for the radial artery and a standard dual Judkins (5F R4, L4; Cordis Corporation, Miami, FL) catheter were compared. The procedure time and fluoroscopy time were shorter in the Tiger II catheter group. While it had the same success in left coronary angiograms, Tiger II catheter was found to be more successful in right coronary angiogram. No angiographic or clinical complications were detected in either group. In 2016, Chen *et al*. [13] compared the radial artery-specific Tiger catheter (5F, Terumo Interventional Systems, Somerset, NJ) with standard JL and JR (5F R4, L4; Cordis Corporation, Miami, FL) catheters. Fluoroscopy time was significantly lower in a single catheter. However, the success of the procedure was found to be higher with dual catheters. In the study of Xanthopoluo *et al*. [7], Tiger II (Tiger II (Terumo Corporation, Tokyo, Japan) catheter and standard dual Judkins (R4, L3.5; Medtronic, Minneapolis, MN) catheter) catheters were compared. The amount of contrast material used, fluoroscopy time, procedure time and spasm rate were found to be less in the Tiger II group. While it was better in RCA imaging, Judkins group was better in left system imaging. In the study of Schneider *et al*. [6], a single catheter group using Tiger II (Terumo Interventional Systems, Somerset, NJ) and BLK (Terumo Interventional Systems, Somerset, NJ) catheters and dual catheter group using standard Judkins (Terumo Interventional Systems, Somerset, NJ) catheters were compared. Coronary angiography with a single catheter does not reduce the procedure time, but also increases the fluoroscopy time and the amount of contrast used.

It is not always possible to reach specific catheters for radial coronary imaging. For this reason, in some studies, instead of special catheters, JL catheters used in standard coronary angiography for both coronary imaging were used. In the study of Turan *et al*. [14], JL 3.5 catheter was used as multipurpose catheter, and JL 3.5 and Judkins right (JR) 4 catheters were used in the dual catheter group. Success was achieved with a single catheter in 66% of cases, and additional catheter use was more necessary than in the dual catheter group. Although the procedure time was shortened in the single catheter group, there was an increase in fluoroscopy time. More spasm occurred in the dual catheter group. In the study of Erden *et al*. [15], JL 3.5 catheter shaped like a Jacky catheter was used in the single catheter group, and standard JL 3.5 and JR 4 catheters were used in the dual catheter group. The need for additional catheters was higher in the single catheter group. Fluoroscopy time was less in the single catheter group. The procedure time was also significantly less when the time used to shape the single catheter was not included. Radial artery spasm was also detected more frequently in the dual catheter group. In a meta-analysis investigating the performance of standard shaped-JL or custom catheters for transradial coronary angiography, less spasm was detected in the single catheter group [10]. However, more crossovers were made compared to the dual catheter strategy.

In our study, we compared a single JL 4 catheter and a standard dual catheter for right and left coronary angiography by entering through the right radial artery. Procedural success, complication rate and procedure time were similar between the two groups. However, the duration of fluoroscopy was found to be longer in the single catheter group. The reason for this is that the operator had the right to make 4 attempts to complete the procedure with a single catheter and the operator's insistence on completing the procedure with a single catheter. Again, in the single catheter group, the amount of radiation exposed due to the length of the fluoroscopy period was higher in the single catheter group, but this value did not reach significance. However, it is obvious that the use of a single catheter is less costly than the use of two catheters.

Limitations

The limitations of our study can be listed as follows: i) the small number of patients, ii) the absence of a group consisting of a special single catheter used for the right and left systems, iii) the procedure being performed by experienced operators (this may in-

crease the possibility of the procedure being subjective), iv) only the right radial artery use for the procedure.

CONCLUSION

In our study, in which a single JL catheter and a standard dual catheter were used for right radial coronary angiography, the duration of fluoroscopy was found to be longer in the single catheter group. Other procedural outcomes such as procedural success and complication rate were similar. Randomized, large-scale studies are needed on the use of the left JL 4 catheter in imaging the left and right systems with a single catheter.

Authors' Contribution
Study Conception: HA, SÇ, TB; Study Design: HA, TB, BU, MM; Supervision: TB, MM, HA; Funding: SÇ, BU, MK, GÖ; Materials: BU, BÇ, AT, MK; Data Collection and/or Processing: BU, BÇ, AT, MK, SÇ; Statistical Analysis and/or Data Interpretation: HA, MM, SÇ; Literature Review: SÇ, BÇ, AT, MK, GÖ, SA; Manuscript Preparation: HA, SÇ and Critical Review: TB, MM, GÖ.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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