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The protective role of low-dose acetylsalicylic acid use and relation with inflammatory and thrombotic parameters on radial artery occlusion in patients undergoing elective transradial coronary angiography

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ABSTRACT

Aim: Transradial angiography (TRA) is recommended in clinical practice; it is better than the transfemoral route to prevent site-related complications. Radial artery occlusion is one of the most seen significant complications after TRA. In the present study, the protective effect of low dose acetylsalicylic acid (ASA) use against the radial artery occlusion (RAO) and the predictive ability of some thrombotic and inflammatory factors for the development of RAO were investigated.

Material and Method: One thousand two hundred fifty-four patients who planned for elective coronary angiography were screened to include transradial coronary angiography. The patients have grouped group I, who took ASA (100 mg) (n= 56), and group II (n= 51), who did not. Blood samples were taken immediately after sheath insertion and after the six hours of the sheath removal. The D-dimer and C-reactive protein values were analyzed between groups. In the first 24 hours after the procedure, the radial Doppler ultrasonography assessment was performed to detect RAO. Multivariable regression analysis was used to evaluate the independent risk factors for the TRA.

Results: Eligible one hundred seven stable patients were included in the study. The demographic, laboratory and procedural characteristics were similar between the two groups (Table 2). TRA was statistically lower in Group I compared to Group II. (n=3 vs. n=22, p=.001). Multivariable regression analysis demonstrated that postprocedural higher D-dimer levels and non-ASA status were found to be the independent risk factors for RAO (OR (95% CI=1.235(1.014-1.582) p=.001, 5.534 (3.376-9.252), p <.001). ROC analysis demonstrated the cut-off value of the D-dimer level was 144 ng/ml for predicting RAO (AUC =0.658, sensitivity 62.4%, specificity 89.2%, p=.016). Preprocedural and postprocedural CRP values did not differ between groups (p>.05).

Conclusion: Preprocedural ASA use may have a protective role against the RAO. Pre- and post-procedural D-dimer levels can predict the thrombotic process in the early phase of the RAO.

Keywords: Acetylsalicylic acid, radial artery occlusion, D-dimer, C-reactive protein, protection

INTRODUCTION

Transfemoral and transradial access are the most commonly used entry routes for coronary angiography (CAG). The operators nowadays prefer transradial access (TRA) since it has proven safer than transfemoral access (TFA) to diagnose and treat cardiovascular atherosclerotic disease (1,2). Radial artery occlusion is one of the procedural complications after transradial procedures. Impaired local endothelial functions and the development of thrombotic processes are shown as the leading cause of radial artery occlusion. The development of this complication is mainly minimized by applying routine intraradial anticoagulation, administering vasodilator drugs via the sheath, and patent homeostasis, besides using contralateral ulnar compression and selecting small-caliber sheaths, catheters, etc. (2-7).

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D-dimer is a blood parameter obtained from a complete blood count measurement, showing fibrin formation and degradation. It usually is present in a low amount in serum in healthy individuals, but it shows a severe increase in serum in individuals who develop any thrombotic events. D-dimer is routinely used to diagnose and follow up venous thromboembolism (VTE) and pulmonary thromboembolism (PR). And also; It is used for the diagnosis of disseminated intravascular coagulopathy (DIC), to determine the risk of stroke in patients with atrial fibrillation, to predict the development of cardiovascular events in patients with coronary artery disease (CAD) and HIV infection, or to exclude acute aortic dissection (8).

Acetylsalicylic acid (ASA) is a widely used agent with proven efficacy in treating broad atherothrombotic vascular diseases. It exerts its antithrombotic effect by suppressing platelet activation by inhibiting the cyclooxygenase (COX) pathway. It is a protective effect over arterial and venous thromboembolic events is well known (9-11). However, ASA's clinical effectiveness for preventing radial artery occlusion (RAO) is not well defined. This study aimed to assess the protective role of low-dose ASA use before the transradial CAG and a relationship between RAO and hematologic, inflammatory parameters such as CRP and D-dimer.

MATERIAL AND METHOD

The study was carried out with the permission of Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Researches Ethics Committee (Date: 23.09.2019, Decision No:72/02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Population

This study is a single-center, prospective, observational study. That included the patients who underwent coronary angiography from the right radial route between July 2018 and August 2020. The patients' data were obtained from the hospital automation system, and the anamnesis was taken from the patient themself.

1254 patients who underwent transradial coronary angiography were analyzed for the study. After excluding the patients with an exclusion, then the patients in the aspirin-taking (100mg) and non-aspirin (100mg) groups were matched according to their demographic, laboratory, and procedural characteristics. The appropriate patient groups to be included in the study were determined. Finally, 107 patients, aged between 32 and 85 years, who underwent right radial route CAG for the first time by their physician, and who had no abnormality in Allen and Barbeau tests were included. The patients involved in the study underwent planned elective coronary angiography and had aortic root width and configuration within normal limits, no coronary outflow anomaly, stable hemodynamics, and no common pathology on the radial artery side where the sheath was placed. Blood samples for D-dimer were obtained from blood taken from the radial sheath after coronary angiography, and upper extremity Doppler was performed within 24-48 hours after the procedure. Those who had emergency coronary angiography indication (STEMI, NSTEMI, USAP, Shock, Cardiac arrest), peripheral artery disease, active infection/inflammatory disease, decompensated heart failure, severe valvular disease, chronic kidney disease, malignancy, acute pulmonary thromboembolism, myocarditis/pericarditis, who used anticoagulant or non-aspirin antiplatelet and immunosuppressive therapy, and whose treatment changed after undergoing the procedure were also excluded from the study.

Coronary Angiography

Repa brand 5F-6F radial sheaths (Repa Group Health Products Co, Ltd., Turkey) were placed in the patient's right radial artery. Single-wall anterior puncture with micropuncture needle method was used. All patients were routinely given 5000 Units of heparin and a varying amount of nitroglycerin via transradial route at 50-1000 mcg doses to prevent the development of radial occlusion according to their hemodynamic status. The procedure was performed using a Judkins 4 left catheter at the left coronary artery and a Judkins 4 right catheter at the right coronary system. Following coronary angiography, the sheath was immediately removed from the artery; a manual homeostasis control was performed to provide radial homeostasis, as typically used by many operators (12). No other homeostasis method was used in the patients.

Doppler Ultrasonography

In the first 24 hours after the procedure, the radial doppler ultrasonography (USG) assessment was performed by the experienced physicians working in the radiology outpatient clinic's doppler USG laboratory using the Aplio 500 Tokyo device with the linear 7.5 MHz high-resolution probe (Toshiba, Japan).

Laboratory Analysis

Blood samples were taken immediately after the procedure (basal blood samples) from the radial sheath and at the 6th hour after sheath removal from the peripheral venous route. The D-dimer value was measured using the ACL TOP 700 coagulation analyzer (Instrumentation Laboratory Company, Germany). Using Fab fragments, the detection of the D-dimer

value was achieved more precisely, and the interference of some endogenous factors such as the rheumatoid factor was prevented. The D-dimer reference value was 0-243 ng/ml. Automatic hematology analyzers (Symex XN-550 analyzer, Symex, Kobe, Japan) were used to measure whole blood parameters; biochemistry devices carried out biochemical analyses (Beckman Coulter Inc., Brea, New York, USA).

Statistical Analysis

Categorical data were presented as numbers and percentages. The chi-square test was used in the analysis of non-parametric data. All the variables obtained were examined with the Kolmogorov-Smirnov test for normality and the Levene test for homogeneity of variances before the significance tests were made. An independent t-test was used for homogeneous data showing normal distribution in evaluating the differences. The Mann-Whitney U test was used for the parameters not showing normal distribution. The receiver operating characteristic (ROC) analysis was used to estimate the optimal cut-off value of D-dimer in RAO patients. Sensitivity, specificity, and area under the curve (AUC) values were calculated. The data were analyzed before multivariate logistic regression analysis with the Shapiro Wilk test for normality and Levene test for homogeneity of variances. Afterward, the significance tests were performed in terms of all variables. The univariate logistic regression analysis was first applied to all variables, and the variables related to the presence of RAO were detected. These variables were then used as candidate variables to enter the multivariate logistic regression model to determine the risk factors for the disease. The backward subtraction method was employed in the multivariate logistic regression model, and the Wald statistics tested the significance of the variables. The variables that were not significant in the multivariate model were excluded from the regression model, and odds ratios were used to interpret the final model. The ROC analysis was performed with Medcalc 9.2.0.1 software, while other statistical analyses were conducted with IBM SPSS 23.0 (IBM Corp., Armonk, NY, USA) statistical software package. The significance level was considered 2-sided p <.05 for all statistical analyses.

RESULTS

A total of 107 patients were included in the study. The mean age of the patients was 56.5±11.9. 51 (47.6%) patients were male. A total of 25 (23.4%) patients had RAO. The patients' baseline demographic and laboratory characteristics are summarized in **Table 1.**

Table 1. Baseline characteristics of all patients included in the study.

Demographic Characteristics	**N=107**
Age, year	56.5±11.9
Male, n (%)	51 (47.6)
Diabetes mellitus, n (%)	50 (46.7)
Hypertension, n (%)	71 (66.4)
Hyperlipidemia, n (%)	43 (40.2)
Smoking, n (%)	48 (44.9)
Coronary artery disease, n (%)	28 (26.2)
CAG Story, n (%)	8 (7.5)
Height, cm	169.1±9.4
Weight, kg	84.3±15.8
Radial occlusion, n (%)	25 (23.4)
Medications	
Use of beta-blockers, n (%)	35 (32.7)
Use of ACE-I, n (%)	34 (32.8)
Statin use, n (%)	33 (30.8)
Use of Aspirin, n (%)	56 (52.3)
Procedural characteristics	
Amount of nitrate given, mcg	248.5±152.6
Amount of heparin given, Unit	4816±737
Sheath size (f)	5.28±0.45
Laboratory Characteristics	
Hemoglobin, g/dL	13.5±1.4
WBC, cells/mL	8.6±2.9
Creatinine, mg/dl	0.83±0.25
Platelet, cells/mL	266.8±69.8
APTT, sec.	29.2±3.4
INR	1.33±0.39
LDL, mg/dL	122.8±38.3
HDL, mg/dL	43.69±9.8
TG, mg/dL	186.31±104.8
HBA1C, mmol/ml	6.7±1.5
TSH, mIU/l	1.86±1.2
CRP (Basal), mg/l	4.39±2.49
CRP (at 6.hr.), mg/l	5.27±2.36
Δ-CRP, mg/l	0.87±0.41
D-dimer (Basal), ng/ml	105.3±58.8
D-dimer (at 6.hr), ng/ml	126.14±65.55
Δ-D-dimer, ng/ml	20.85±16.48

CAG: Coronary Angiography, ACE-I: Angiotensin-converting enzyme-inhibitors, APTT: activated partial thromboplastin time, WBC: White blood cell, LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: Triglycerides, HBA1c: glycosylated hemoglobin, TSH: Thyroid-stimulating hormone, CRP: C-Reactive protein, Δ: Delta

Patients were divided into two groups according to their ASA use status. Patients using ASA were classified as group 1, and patients not using ASA were classified as group 2. Radial occlusion was significantly higher in patients not using ASA (22 (43.1%) vs. 3 (5.4%), p=<.001). No difference was found between these patients' procedural features and laboratory data. In demographic data, only CAD and statin use were higher in patients using aspirin, and other findings were similar (**Table 2**).

Table 2. Essential characteristics of patients according to their aspirin use status

Demographic characteristics	Group I, n=56	Group 2, n=51	p value
Age, year	56.75±12.78	56.27±11.16	.83
Male, n (%)	26 (46.4)	25 (49)	.47
Diabetes mellitus, n (%)	30 (53.6)	20 (39.2)	.09
Hypertension, n (%)	37 (66.1)	34 (66.7)	.55
Hyperlipidemia, n (%)	27 (48.2)	16 (31.4)	0.11
Smoking, n (%)	25 (44.6)	23 (45.1)	.55
Coronary artery disease, n (%)	21 (37.5)	7 (13.7)	.008
Height, cm	168.73±8.56	169.61±10.42	.63
Weight, kg	83.04±14.46	85.69±17.18	.38
Radial occlusion, n (%)	3 (5.4)	22 (43.1)	<.001
Medications			
Use of beta-blockers, n (%)	20 (35.7)	15 (29.4)	.31
Use of ACE-I, n (%)	17 (30.4)	17 (33.3)	.45
Statin use, n (%)	22 (39.3)	11 (21.6)	.038
Procedural characteristics			
Amount of nitrate given, mcg	255.46±170.69	241.18±131.79	.63
Amount of heparin given, unit	4700±649.78	4941±810.22	.09
Sheath size (f)	5.28±0.45	5.29±0.46	.92
Laboratory characteristics			
Hemoglobin, g/dl	13.38±1.46	13.71±1.38	.23
WBC, cells/mL	8.69±3.07	8.58±2.91	.85
Creatinine, mg/dl	0.83±0.26	0.82±0.24	.75
Platelet, cells/mL	256.86±65.40	277.75±73.56	.12
MPV, fl	8.09±0.80	8.38±0.85	.07
APTT, sec.	29.94±3.18	29.71±3.74	.72
INR	1.33±0.42	1.35±0.51	.61
LDL, mg/dL	123.73±40.32	121.86±36.34	.79
HDL, mg/dL	43.26±10.04	44.45±9.74	.45
TG, mg/dL	187.88±98.21	184.60±112.63	.87
HBA1C, mmol/ml	6.94±1.73	6.43±1.45	.13
TSH, mIU/l	1.83±1.15	1.91±1.31	.73
CRP, mg/l	4.22±2.31	4.58±2.69	.45
CRP (at 6.hr.), mg/l	5.13±2.31	5.43±2.68	.53
Δ-CRP, mg/l	0.90±0.34	0.84±0.06	.42
D-Dimer, ng/ml	100.18±61.19	110.92±56.27	.34
D-dimer (at 6.hr), ng/ml	118.25±63.82	134.82±66.95	.19
Δ- D-dimer, ng/ml	23.90±19.34	18.07±12.91	.07

CAG: Coronary Angiography, ACE-I: Angiotensin-converting enzyme-inhibitors, APTT: activated partial thromboplastin time, WBC: White blood cell, LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: Triglycerides, HBA1c: glycosylated hemoglobin, TSH: Thyroid-stimulating hormone, CRP: C-Reactive protein, Δ: Delta

When the patients are evaluated according to the development of radial occlusion; in patients with radial occlusion; basal D-dimer (135.20±66.58 ng/ml vs. 96.18±53.49 ng/ml, p=.003), D-dimer at 6 hours post-procedure (172.16±81.34 ng/ml vs. 112.12±53.01 ng/ml, p=.002), and post and the pre-procedure difference between the D-dimer values (Δ- D-dimer) (36.96±26.12 ng/ml vs. 15.93±6.98 ng/ml, p=.001) was found to be significantly higher. Again, basal MPV values were higher in the group with radial occlusion (8.34±0.82 fl vs. 7.92±0.81 fl, p=.028). Other findings do not show any difference between the two groups (**Table 3**).

Table 3. Essential characteristics of patients according to radial occlusion status.

Demographic Characteristics	Radial occlusion n=25	No radial occlusion n=82	p value
Age, year	54.84±10.06	57.04±12.51	.42
Male, n (%)	14 (56)	37 (45.1)	.23
Diabetes mellitus, n (%)	8 (32)	42 (51.2)	.11
Hypertension, n (%)	18 (72)	53 (64.6)	.63
Hyperlipidemia, n (%)	6 (24)	37 (45.1)	.06
Smoking, n (%)	14 (56)	34 (41.5)	.25
Coronary artery disease, n (%)	3 (12)	25 (30.5)	.07
Height, cm	170.36±10.75	168.78±9.07	.46
Weight, kg	87.44±19.61	83.34±14.44	.51
Aspirin use n	3 (12)	53 (64.6)	<.001
Medications			
Use of beta-blockers, n (%)	8 (32)	27 (32.9)	.56
Use of ACE-I, n (%)	8 (32)	26 (31.7)	.58
Statin Use, n (%)	6 (24)	27 (32.9)	.27
Procedural characteristics			
Amount of nitrate given, mcg	271.05±140.74	241.36±156.28	.35
Amount of heparin given, unit	5040±1098.48	4796±576.21	.21
Sheath size (f)	5.16±037	5.32±0.47	.11
Laboratory characteristics			
Hemoglobin, g/dL	13.65±1.58	13.56±1.38	.66
WBC, cells/mL	8.65±3.17	8.63±2.93	.97
Creatinine, mg/dl	0.76±0.24	0.85±0.25	.15
Platelet, cells/mL	277.72±77.02	263.49±67.70	.41
MPV, fl	8.34±0.82	7.92±0.81	.028
APTT, sec.	29.57±3.13	29.90±3.54	.67
INR	1.32±0.32	1.34±0.43	.53
LDL, mg/dL	116.96±37.84	124.60±38.49	.38
HDL, mg/dL	42.12±10.11	44.17±9.82	.37
TG, mg/dL	206.31±109.06	180.22±103.43	.29
HBA1C, mmol/ml	6.57±1.87	6.74±1.51	.69
TSH, mIU/l	1.92±1.41	1.85±1.17	.78
CRP, mg/l	3.92±2.08	4.53±2.60	.23
CRP (at 6.hr.), mg/l	4.91±2.18	5.38±2.57	.37
Δ-CRP, mg/l	0.98±0.51	0.84±0.38	.13
D-Dimer, ng/ml	135.20±66.58	96.18±53.49	.003
D-dimer (at 6.hr), ng/ml	172.16±81.34	112.12±53.01	.002
Δ- D-dimer, ng/ml	36.96±26.12	15.93±6.98	.001

CAG: Coronary Angiography, ACE-I: Angiotensin-converting enzyme-inhibitors, APTT: activated partial thromboplastin time, WBC: White blood cell, LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: Triglycerides, HBA1c: glycosylated hemoglobin, TSH: Thyroid-stimulating hormone, CRP: C-Reactive protein, Δ: Delta

As a result of the regression analyses performed to determine the risk factors indicating the development of radial occlusion, according to univariate regression analysis, MPV, basal D-dimer, 6th-hour D-dimer, and not using ASA were found to be predictive factors for the RAO. Multivariable regression analysis results also showed that; not using AS, high basal, and 6th-hour D-dimer values are independent risk factors for RAO development (**Table 4**).

Table 4. Factors of predicting the development of radial artery occlusion after transradial angiography.

Risk Factor	Univariable analysis		Multivariable analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
MPV	1.005 (1.002-1.011)	.029	0.607 (0.299-1.236)	.16
D-dimer (basal)	1.011 (1.003-1.018)	.008	1.235 (1.014-1.582)	.001
D-dimer (at 6. Hr.)	1.013 (1.006-1.021)	<.001	1.232 (1.097-1.384)	<.001
Not taking aspirin	5.402 (3.695-9.611)	<.001	5.534 (3.376-9.252)	<.001

MPV: Mean Platelet Volume

Table 5. ROC analysis results of D-Dimer values.

	Cut- off	Sensitivity	95% CI	Specificity	95% CI	AUC	p
D-Dimer	>144*	62.4*	41.3–82.2	89.2*	80.2-94.8	0.658	0.016*

ROC: Receiver operating characteristics, CI: Confidence interval, AUC: Area under the curve

Regarding the significance of D-dimer in predicting RAO as a result of ROC analysis, the AUC was 0.658 (95%CI: 0.612-0.738, p= .016), and the optimal cut-off value was 144 (62.4% sensitivity, 89.2% specificity) (**Figure 1**).

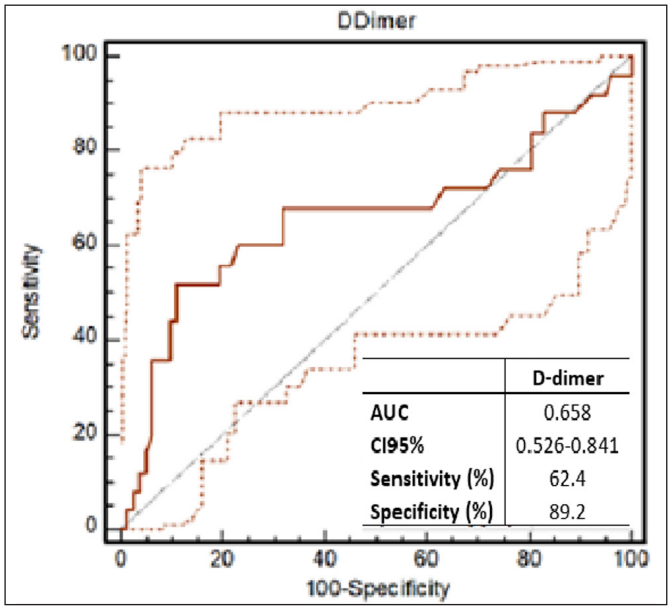

Figure 1. Receiver operating characteristics (ROC) analysis curve of D-dimer values

DISCUSSION

When the current literature is examined, our study is the first and only study evaluating the relationship between RAO and ASA use and the relationship between RAO, CRP, and D-dimer. In this study, D-dimer values obtained immediately after the procedure (basal D-dimer) were compared, and the RAO group values were higher than the non-RAO group (135.2 ng/ml ± 66.5 vs. 96.1 ng/ml ± 53.4 p=.017). As a result of multivariable logistic regression analysis, the basal D-dimer value was an independent risk factor for RAO development. Since patients with thromboembolic and active infectious/inflammatory diseases were excluded from the study, high basal D-Dimer values in these patients without a dynamic, active thrombotic process showed that fibrin production and destruction were higher in the basal state of the body and that the coagulation cascade, which will become much more active after an intravascular intervention such as angiography, suggests that it triggers thrombus development much faster and more (13). The D-dimer results indicated that choosing the vascular access route according to the basal D-Dimer value might be beneficial in preventing RAO in patients. For this purpose, the D-dimer value of 144 ng/ml can be considered a practical and easily applicable cut-off value for radial or femoral route selection before the CAG procedure. One study revealed that pre-operative D-dimer values predicted post-operative graft thrombosis in patients who had previously undergone coronary artery bypass grafting (CABG) and received arterial grafts supports our research (14). On the other hand, in the study of Kleinegris et al. (15) in peripheral arterial patients, it was determined that increased D-dimer values increase coronary and arterial thrombotic events, which supports that radial occlusion may result in increased thrombosis in patients with high D-dimer values. In addition to all this, the increase in D-dimer at the 6th hour is higher in patients with RAO (172.16±81.34 ng/ml vs. 112.12±53.01 ng/ml, p=.002). The result of the ROC analysis also supports this; although the sensitivity is low (62.4%), it has a high specificity (89.2%) because it is not in a situation to explain anything else. There is no other condition to explain this D-dimer elevation in the patient group in our study. This result may enable us to predict RAO development in patients who underwent TRA, even if they are asymptomatic in the post-procedure follow-up.

It has been known for a long time that the use of ASA has a protective effect against many thrombotic vascular diseases (16). It is also widely used in coronary syndromes, venous thromboembolism, prevention and treatment of stroke, as demonstrated in the guidelines (17,18). Although prophylactic use has been evaluated to protect

some arterial access routes in previous studies, no study shows that it is protective against RAO in TRA, which is becoming increasingly common today. In our research, RAO was found to be significantly lower in patients using low-dose ASA before TRA (22 (43.1%) vs. 3 (5.4%), p=<.001). Here, it is thought that ASA reduces endothelial damage by regulating local endothelial functions and inhibits the COX pathway, reducing platelet efficiency and reducing the possible microthrombi, reducing gross thrombosis that will develop over these microthrombi, and reducing RAO (19).

While evaluating the safety of TRA, it was compared with TFA in general, and major complications were assessed both in themselves and in comparison, with TFA. The development of RAO was low and was not subjected to a direct evaluation in all essential and extensive studies such as; RIVAL, MATRIX, ARTEMIS, RIFLE-STEACS, SAFARI-STEMI (20-24). At the same time, most of the patients in these studies were acute coronary syndromes (ACS) patients and had multiple systemic thrombotic complications, making it challenging to evaluate only RAO. On the other hand, it was not possible to assess the efficacy of ASA alone since these patients used multiple drugs (clopidogrel, ticagrelor, prasugrel, etc.). For this reason, those studies may help predict the safety and efficacy of the TRA, especially in patients who will undergo elective CAG; however, they do not provide reliable and direct information on the prevention of complications that may develop in the radial artery in the elective procedures. The rates of ASA use in our study were correlated with previous studies. Still, the incidence of RAO detected in these studies was lower than that obtained in our study. RAO was seen in 25 (23.4%) patients in our study. Post-procedure RAO has been observed at 1 to 38% in large-center, multi-participant studies (25). Our study's high rate of radial occlusion (23.4%) may have been due to the operators' lack of experience in CAG procedures performed using the transradial artery and a manual compression method with a classical radial bandage homeostasis control. Due to not using transradial bands for homeostasis, complete homeostasis control based on manual compression with the applied plaster may have caused more stasis in the radial artery. These situations caused thrombosis to elevate, thus increasing the occlusion of the radial artery in the patients. This finding seems consistent with studies comparing homeostasis methods in the literature (26). On the other hand, a few studies detected no difference between manual and mechanical compression in RAO; however, in that study, the duration of manual compression was kept very short compared to mechanical compression (27,28). The absence of multiple antiaggregant uses and standard-dose heparin and providing complete homeostasis with manual compression can be shown as the reason for this outcome (20,21,23,29).

RAO is less common in patients with hyperlipidemia in this study; this may be because these patients are currently using statins. In the study of Charles Hsu et al. (30), statins in patients with deep venous thrombosis increased thrombus resolution support our results. At the same time, stabilizing endothelial functions due to the pleiotropic effects of statins may have contributed to less occlusion by reducing catheter-based endothelial damage, independently of atherosclerotic load and cholesterol level (30,31).

The study's limitations are that it was observational, modern homeostasis methods were not used, and a limited number of patients participated. The findings need to be confirmed in a large-scale randomized controlled trial.

CONCLUSION

The D-dimer values measured before CAG provide information about the probability of RAO development after the procedure and may be a guide for selecting the vascular access route.. There is a direct relationship between RAO and ASA use, which reduces RAO's development. For this reason, in patients with high D-dimer values, avoiding the radial route and using prophylactic ASA before the procedure may prevent the development of this complication and reduce patient suffering. Prospective studies comparing different antiaggregant and anticoagulant regimens may be planned to determine the importance of ASA and D-dimer's clinical role in developing RAO.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Researches Ethics Committee (Date: 23.09.2019, Decision No:72/02).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version

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