IVYSPRING INTERNATIONAL PUBLISHER

International Journal of Medical Sciences

2013; 10(12):1715-1719. doi: 10.7150/ijms.7087

Research Paper

Incidence and Predictors of Radial Artery Occlusion Associated Transradial Catheterization

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Received: 2013.07.04; Accepted: 2013.08.21; Published: 2013.10.03

Abstract

In this study, we sought to assess the incidence and predictors of radial artery occlusion (RAO), which is a significant complication of transradial cardiac catheterization. We prospectively evaluated the results of 106 patients who underwent coronary angiography and percutaneous coronary intervention (PCI) via the transradial approach (TRA). At the 3rd h of intervention, the radial artery was checked by palpation; color doppler ultrasonography was performed at the 24th h. Fluoroscopy duration, procedure success, and complications of the radial artery were recorded. The procedure was successfully completed in all patients. RAO was detected in eight female and two male patients. In terms of RAO, there was a statistically significant difference between males and females (p=0.019). Other parameters did not show a significant correlation with RAO. Altough did not have any effect on procedural success, eight patients developed transient radial artery spasm. Gender was not associated with radial arterial spasms (p=0.19). TRA in the diagnosis and treatment of coronary artery disease has shown high procedural success and low complication rates; it addition, it presents a low economic burden. It should be used widely and be involved in the routine cardiology residency program.

Key words: Radial artery occlusion; Transradial approach; Radial arterial spasm

INTRODUCTION

Coronary angiography is the gold standard method for the diagnosis and for establishing treatment strategies for atherosclerotic coronary artery disease. Coronary angiography can be performed via femoral, radial, brachial, ulnar, or axillary arteries. The transfemoral approach (TFA) is the most preferred route. However, vascular access site complications such as bleeding, hematoma, arteriovenous fistula, or pseudoaneurysm are quite common after TFA procedures. [1-4] The reduction of ischemic events and complications after percutaneous coronary intervention (PCI) increases the importance of vascular access site and bleeding complications, which were shown to be correlated with morbidity and mortality.[5, 6]

Even though intense antiplatelet and anticoagulant usage is common in coronary interventions via transradial approach (TRA), vascular access site complications occur less often than via TFA. In terms of procedural success, TRA is as safe as TFA in primary and rescue PCI, and vascular site complications

are less than TFA after thrombolytic therapy. [7] TRA is preferred by patients and physicians because it allows for greater patient comfort, shorter durations of hospitalization and reduced costs of treatment. [8-10] Because of those results, the European Society of Cardiology Guidelines of Management of Acute Myocardial Infarction in patients presenting with ST-segment elevation has given priority to transradial over TFA.[11]

Radial artery occlusion (RAO) appears to be a significant problem after radial artery catheterization; it has been reported at rates ranging from 2% to 18% in several studies.[12] Anticoagulant dose, gender, the patient's body weight, the diameter of the radial artery, sheath size, the number of catheters, procedure duration, hemostatic compression method, and compression time after the procedure are some of the factors associated with RAO. [13] In this study, the incidence and predictors of RAO in patients undergoing transradial catheterization were evaluated.

METHODS

Study population

This is a prospective non-randomized study in which the results of the 106 patients who underwent elective coronary angiography and PCI via TRA between August 2011 and March 2012 were evaluated. Patients with prior radial intervention, pathological Allen tests, cardiogenic shock, decompensated heart failure, severe valvular disease, and chronic renal failure were not included in the study. The study protocol was approved by the local ethics committee of Turkish High Specialty Hospital, Ankara and followed the latest version of the Declaration of Helsinki. Informed consent was obtained from patients.

Procedure details

The Allen test was performed on all patients prior to the intervention. The Allen test is used to test blood supply to the hand, specifically the patency of the radial and ulnar arteries.[14] Pressure is applied over the ulnar and radial arteries so as to occlude both of them. After the ulnar pressure is released, color should return within 7 s. If the color does not return or returns after 7–10 s, the test is considered pathological and the ulnar artery supply to the hand is deemed not sufficient. Six French 11 cm sheaths and 0.021 inch guide wires were used. After sheath replacement, 200 µg nitroglycerin, 2.5 mg verapamil, and 5000 IU unfractioned heparin were injected through the side-arm of the sheath. Heparin dosage was calculated according to the weight of patients undergoing PCI. Radial sheaths were removed just after the procedure and compression was performed for 2 h. Fluoroscopy durations, whether or not radial artery spasms developed and their effect on procedural success were also recorded. The patency of the radial arteries was checked by palpation and color. Doppler ultrasonography was conducted 24 h following the procedure. Major bleeding was graded using the REPLACE-2 (Randomized Evaluation in PCI Linking Angiomax to Reduced Clinical Events-2 trial) classification. [15] This includes intracranial, intraocular, or retroperitoneal hemorrhage; clinically overt blood loss with a decrease in hemoglobin 3 g/dL; any decrease in hemoglobin >4g/dL without overt bleeding. Transfusions of ≥2 units of blood products and less bleeding that do not meet these criteria were considered minor bleeding.

Statistics

Statistical analyses were performed using the SPSS 17.0 (SPSS Inc, Chicago, Illinois). Continuous variables were expressed as mean ± standard deviation whereas categorical variables were given as numbers (percentages). The comparison between groups was done by Mann-Whitney U test for continuous variables and by Chi-square or Fisher`s exact test for categorical variables. $P < 0.05$ was considered statistically significant.

RESULTS

Demographic and procedural characteristics of patients are outlined in Table 1. The procedure was successfully completed in all patients. The mean fluoroscopy duration of diagnostic angiography was 2.75 ± 1.5 min. In patients undergoing PCI, the average fluoroscopy duration was 8.29 ± 5.1 min [Table 1]. Eight transient radial arterial spasms did not affect procedural success. Although radial arterial spasms were seen more in female patients than in males, the difference was not statistically significant. RAO developed in 10 patients. There were no major bleeding episodes. Pseudoaneurysm developed in a patient and two cases of minor radial hematoma (diameter less than 5cm) were observed.

The difference between patients with and without RAO is depicted in Table 2. RAO developed in two male and in eight female patients; this difference was statistically significant (p=0.019). When body weight was compared between patients with and without RAO, no significant difference was observed (Z= -1.466, p=0.146). Other conditions and medications were not associated with RAO [Table 2].

Table 1: Demographic and clinical characteristics of the patients

Demographic features	*N*=106
Age (years)	58±11
Weight (kg)	80.7±14.6
Height (cm)	170.2±8.6
BMI (kg/m²)	27.4±3.9
Gender, *n* (%)	
Male	46 (43,4)
Female	60 (56.6)
Hypertension, *n* (%)	86 (81.1)
DM, *n* (%)	37 (34.9)
Hyperlipidemia, *n* (%)	90 (85)
Smoking, *n* (%)	50 (47.2)
Procedural characteristics	
Flurosocopy duration	
Coronary angiography	2.75±1.5 min
Coronary intervention	8.29±5.1 min
Transient radial spasm, *n* (%)	8 (7)
RAO, *n* (%)	10 (9)
Complications	
Pseudonaeurysm, *n*	1
Radial hematoma, *n*	2

BMI: Body mass index; DM: Diabetes mellitus, RAO: Radial artery occlusion

Table 2: Results of the patients in terms of RAO

	RAO (+) *N*=10	RAO (−) *N*=96	*P*
Female gender, *n* (%)	8 (80)	52 (54)	0.02
TRA site, right/left	7/3	55/41	0.69
Low-weight, *n* (%)	8 (80)	40 (42)	0.01
Smoking, %	60	46	0.75
Antiaggregant use, %			
Acetylsalicylic acid	90	81	0.11
Clopidogrel	90	77	0.83

RAO: Radial arterial occlusion, TRA: Transradial approach

DISCUSSION

In this study, comparable with previous studies, TRA has high procedural success, low complication rates, and presents a low economic burden in experienced hands in the diagnosis and treatment of coronary artery disease. Recent trials (Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL) and Radial versus femoral randomized investigation in ST-Elevation acute coronary syndrome (RIFLE-STEACS) studies) have shown significant clinical benefits in terms of both lower morbidity and cardiac mortality in patients with ST-segment elevation acute coronary syndrome.[10,16, 17]

Radial artery spasm is the most important factor that can develop during TRA and which may affect the success of the operation Despite this, radial artery spasms have been reported in the range of 6-10% in many studies.[18-21] In our study, a total of eight patients developed transient radial artery spasms (7.5%). Of these patients, three were male and five were female.

Failure of penetration to the radial artery, spasmotic or anatomical barriers such as radial arterial loop, and failure of coronary artery cannulation are the most common causes of procedural failure via TRA. [22] In a study conducted by Dehghani *et al.*, the causes of PCI failure via TRA were radial arterial spasm, subclavian tortuosity, inadequate guiding catheter support, failure of radial artery penetration, radial arterial dissection, and radial arterial loop.[23] In our study, only two patients required a change in the intervention site (1.8%) because of the radial artery loop. Several studies demonstrated that with increasing operator experience, radial procedural failure dropped below 5%.[19, 24] In angiographic series via TRA, pseudoaneurysm was reported rarely and surgery was not required. Pseudoaneurysm developed in 1 of 106 patients in our study. In our study, pseudoaneurysm developed in one patient and two cases of minor hematoma were observed.

Although TRA has several advantages over TFA, increased fluoroscopy durations and radiation exposure are the disadvantages of TRA. [25] In our study, the average fluoroscopy duration of diagnostic angiography was 2.75 ± 1.5 min. In patients undergoing PCI, average fluoroscopy duration was 8.29 ± 5.1 min. These values are similar to those found in previous studies. [25, 26]

The most common complication of TRA is RAO, which can be detected in the range of 2-18%.[27-30] Risk factors for RAO are no anticoagulant use, prolonged high-pressure compression of the radial artery, small radial artery to sheath ratio, smoking, and recurring procedures. [27-30] Thrombus formation appears to be involved in the pathophysiology of early RAO. [12] Heparin therapy is necessary for the prevention of RAO. [27-30] There was no difference between arterial or venous administration of heparin in terms of RAO. [31] In a study conducted by Spaulding *et al.*, RAO rates were 70%, 24%, and 4.3% in groups without heparin, 2000-3000 IU heparin and 5000 IU of heparin, respectively. [32] In another study of TRA, 50 IU/kg and 5,000 IU heparin were compared, but there was no difference in terms of RAO. [33] In our study, 5000 IU and 100 IU/ kg (maximum 10,000 IU) of heparin were used in patients who underwent coronary angiography and PCI, respectively. And we can say the application of higher doses of heparin is associated with low rates of RAO development especially taking

into account time of the process. In 10 of 106 (9.4%) patients, RAO was detected at the 24th h visit. Eight of those patients were female with a weight of <80 kg, while 2 were male with a weight of ≥80 kg. Several studies have reported that female gender and weight are risk factors for RAO occlusion. [27-30, 34] In terms of RAO, there was a statistically significant difference between male and female genders and weight <80 kg and ≥80 kg. This difference between genders can be attributed to the small radial artery to sheath ratio in females. In a study conducted by Sylvain Plante *et al*. a smaller RAO occurrence was detected in patients with body weights of 84 kg or more. [34] Bivalirudin and enoxaparin were found to be as effective as heparin in reducing RAO. [34-35]

Another risk factor for RAO is tight, prolonged compression of the radial artery. The use of compression methods that allow distal blood flow was found to be better than strict compression methods that do not allow distal blood flow in terms of RAO. [36, 37] In our study, 6F sheaths were used in all patients. In recent years, 4F and 5F sheaths have been increasingly used because of less intimal damage and therefore, less RAO. We suggest that the application of higher doses of heparin (9000 IU Average) is associated with low rates of RAO development. There were no relationships between RAO and medications, hypertension, hyperlipidemia, and the smoking status of the patients.

Limitations of the study

Several limitations need to be mentioned. First, this was a prospective observational study with known limitations; randomized, prospective case-control studies are needed to clarify the importance of TRA in elective coronary angiographic procedures. Second, the study population is too small to strengthen the results. Finally, although the experience of the operator has a significant impact on the work, the study was conducted at a single center.

CONCLUSION

Due to the advantages that have been already stated, TRA may be safely and routinely used in eligible patients. To increase the proportion of radial procedures out of all procedures, radial training courses and programs should be involved in routine cardiology residency programs and in post-residency education.

COMPETING INTERESTS

The authors have declared that no competing interest exists.

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