



Should We Use a Staged or Ad hoc Approach in Percutaneous Coronary Interventions Through the Radial Artery to Avoid Radial Artery Spasm?

Gültekin Günhan Demir , Ekrem Güler

ABSTRACT

Objective: Transradial approach has recently been adopted as the default strategy for percutaneous coronary interventions due to benefits which include reduced all-cause mortality, major access-site complications, and hospital stay, as well as increased patient comfort and early ambulation. However, radial artery spasm (RAS) is still a major drawback. The impact on RAS of an ad hoc compared with a staged intervention strategy has not previously been investigated. In this study, we sought to investigate the effect of ad hoc and staged percutaneous coronary intervention (PCI) on RAS in patients undergoing elective transradial coronary interventions.

Materials and Methods: In this retrospective study, patients with symptoms suggestive of ischemia who were scheduled for coronary angiography and candidates for elective PCI were enrolled and divided into two equal groups: ad hoc group and staged group. RAS was clinically identified and established based on the existence of two or more of predefined clinical features.

Results: A total of 60 patients was enrolled in the study: 30 in the ad hoc group and 30 in the staged group. The mean time between coronary angiography and intervention in the staged group was 2.5 [1–30] days. RAS rates were similar between the ad hoc and staged PCI groups (16.7% [n=5] vs. 31% [n=9], $p=0.233$), but post-procedural pain was more frequent in patients in the ad hoc group (64.5% [n=20] vs. 33.3% [n=10], $p=0.021$). Radial artery occlusion did not differ between the ad hoc and staged PCI groups (10.7% [n=3] vs. 11.1% [n=3], $p=1$).

Conclusion: Use of ad hoc or staged strategies in patients undergoing transradial PCIs is not associated with reduced incidence of RAS. Post-procedural pain is more common in patients undergoing ad hoc PCI through radial artery.

Keywords: Radial artery spasm, percutaneous coronary interventions, radial access, coronary artery disease

Cite this article as:
Demir GG, Güler E. Should We Use a Staged or Ad hoc Approach in Percutaneous Coronary Interventions Through the Radial Artery to Avoid Radial Artery Spasm? Erciyes Med J 2020; 42(2): 139–42.

Department of Cardiology,
Faculty of Medicine, İstanbul
Medipol University,
İstanbul, Turkey

Submitted
03.12.2019

Accepted
13.01.2020

Available Online Date
03.02.2020

Correspondence
Gültekin Günhan Demir,
İstanbul Medipol University,
Department of Cardiology,
İstanbul, Turkey
Phone: +90 212 440 10 00
e-mail: ggdemir@gmail.com

©Copyright 2020 by Erciyes
University Faculty of Medicine -
Available online at
www.erciyesmedj.com

INTRODUCTION

Recent technological and scientific advances in the field of interventional cardiology have caused a paradigm shift in access-site selection, and transradial approach has been adopted as the standard of care in the last decade.

Although the transradial approach for coronary angiography and interventions was introduced almost 30 years ago, there has recently been a significant scientific acceleration. Recent guidelines recommend radial access over femoral access for both acute coronary syndromes and planned procedures because of the superior safety, good collateral circulation, and low complication risks associated with radial access.

Although radial approach is associated with reduced complication rates when compared with transfemoral approach, it is not always straightforward. Radial artery spasm (RAS), a common complication characterized by sudden temporary narrowing of radial artery, can be uncomfortable for both the patient and the operator and is associated with procedural failure (1, 2). The association between increased procedural time and RAS is well known, but the impact of ad hoc or staged interventional strategy on RAS has not previously been investigated. The present study aimed to investigate the effect of ad hoc and staged percutaneous coronary intervention (PCI) on RAS in patients undergoing elective percutaneous transradial coronary interventions.

MATERIALS and METHODS

We enrolled a total of 60 patients in this retrospective study conducted in İstanbul Medipol University between December 2018 and February 2019. Patients with symptoms suggestive of ischemia after non-invasive ischemia assessment in the outpatient clinic were referred for scheduled coronary angiography and patients who were considered to be candidates for PCI were divided into two groups based on the timing of revascularization. The first group (ad hoc group) comprised patients allocated to ad hoc PCI and the second group (staged group) comprised patients allocated to staged (or planned) PCI. Group allocations were made based on discussion

with the patient, physician's discretion, and the status of dual antiplatelet therapy. Patients with acute coronary syndrome, cardiogenic shock, aortic dissection, stage III hypertension, chronic total occlusions (candidate for intervention), history of coronary artery bypass grafting with radial artery grafts, chronic renal failure requiring hemodialysis, small radial artery, or weak radial pulse on palpation were excluded. Demographic characteristics of all patients were recorded and patients using medications with vasomotor action such as calcium channel blocking agents, beta-blockers, renin-angiotensin system blockers including angiotensin converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB), long-acting nitrates, alpha-blockers, and statins were noted. Two interventional cardiologists who use a transradial approach as their default strategy performed the procedures in one hemodynamics laboratory, which has a mean annual coronary intervention rate of over 1200. The procedural time in the ad hoc group was calculated by subtracting the diagnostic coronary angiography time from the total procedure duration. The study was approved by the local ethical committee (Istanbul Medipol University Ethic Committee, approval date 27/11/2019, issue number 10840098-604.01.01-E.63381) and the study was carried out in accordance with the Declaration of Helsinki.

A modified Allen's test was applied to all patients to confirm the patency of both radial and ulnar arteries and patients with a positive result and palpable radial artery pulse were included. A left transradial approach was used in all patients. After extension of the arm, the wrist was placed next to the patient's hip, supported by an arm holder. Radial artery puncture was performed with the Seldinger technique with a 22G needle following local anesthesia with lidocaine, and a 6 French×16 cm sheath (Terumo Cardiovascular, Somerset, NJ) was introduced over the wire. Immediately after successful radial artery cannulation, intra-arterial unfractionated heparin (50 IU/kg) and 100 µg nitroglycerin were administered. The total procedural time (diagnostic coronary angiography plus PCI duration), volume of contrast agent, and the duration of use of post-procedural hemostasis device (TR Band) were noted.

RAS was clinically defined based on the existence of at least two of the following five criteria:

- a) Persistent pain in the forearm,
- b) Pain induced by catheter manipulation,
- c) Severe pain during sheath retrieval,
- d) Difficulty in catheter manipulation following entrapment by radial artery,
- e) Significant resistance during sheath retrieval (3).

Radial artery occlusion (RAO) was defined as lack of antegrade flow in the radial artery, confirmed by ultrasound imaging, which was baseline refers to index admission before PCI by modified Allen's test. Ultrasound evaluation of the radial artery was performed 24 hours after cannulation and 30 days after the index procedure.

Hemostasis after the procedure was established by a closure device (Sunmed, TR Closure Device; Sunny Medical, Shenzhen, China) placed on the puncture site for 2 hours with close monitoring and gradually decreasing pressure.

Statistical Analysis

Continuous variables are presented as mean±standard deviation and median (minimum and maximum values), while categorical variables are presented as number of cases (percentage). The normal distribution of variables was tested with Kolmogorov-Smirnov test and confirmed with skewness and kurtosis. Comparison between ad hoc and staged groups was made via unpaired Student's t-test for continuous variables and a Mann-Whitney test was utilized for non-normally distributed continuous data. Fisher's exact and continuity correction (Yate's correction) tests were used for comparison of categorical variables. All data were analyzed using Statistical Package for the Social Sciences (SPSS, version 11.0, SPSS Inc., Chicago, IL, USA). P values less than 0.05 were considered significant for all analyses.

RESULTS

Demographic, clinical, and procedural characteristics of the whole study population are provided in Table 1. A total of 60 patients were divided into two equal groups, which included 30 patients in the ad hoc group and 30 patients in the staged group. The mean age of the study population was 62±8 years old and 44 patients (73.3%) were male. We detected no statistically significant differences between the two groups in the patients' baseline demographic and clinical characteristics, such as age, gender, hypertension, diabetes mellitus, hyperlipidemia, smoking status, blood pressure, and ejection fraction. The procedural time was significantly longer in the ad hoc group than the staged group (45±17 min vs. 33±12 min, p=0.007). Similarly, duration of use of the TR band radial compression device was longer in the ad hoc group than the staged group (108±37 min vs. 98±26 min, p=0.001). No statistically significant differences were found between the groups with respect to medications with potential vasomotor effects, such as calcium channel blockers, nitrates, beta-blockers, statins, and ACEI or ARBs.

RAS rates were similar between the ad hoc and staged PCI groups (16.7% [n=5] vs. 31% [n=9], p=0.233), but post-procedural pain was more frequent in patients in the ad hoc group (64.5% [n=20] vs. 33.3% [n=10], p=0.021). RAO did not differ between the ad hoc and staged PCI groups (10.7% [n=3] vs. 11.1% [n=3], p=1). The median time between coronary angiography and intervention in the staged group was 2.5 (1–30) days.

DISCUSSION

In PCI, transradial route has widely been used as the standard of care since studies recently demonstrated reduced major access-site complications and hospital stay, increased patient comfort, and early patient ambulation and discharge compared to a transfemoral route. Despite overall reduced complications of the radial approach, RAS is still a substantial complication that can lead to severe pain and sometimes procedural failure.

The main finding of our study is that RAS is not associated with the timing (ad hoc vs. staged) strategy of revascularization in patients undergoing elective PCI via a transradial route. However, we detected increased post-procedural pain in the ad hoc PCI group.

RAS causes acute temporary narrowing of the radial artery which is clinically identified as forearm pain, aggravated when the op-

Table 1. Comparison of demographic, clinical, and procedural characteristics of both groups

	Ad hoc	Staged	p
Gender (male %)	20 (62.5)	24 (77.4)	0.274
Hypertension	24 (77.4)	22 (71)	0.772
Diabetes mellitus	13 (41.9)	12 (38.7)	1.000
Hyperlipidemia	17 (54.8)	18 (61.3)	0.797
Smoking status	5 (16.1)	5 (16.1)	1.000
PAD	1 (3.2)	0	1.000
Age (years)	62±9	62±7	0.707
Weight (kg)	78±10	82±11	0.252
Height (cm)	168±7	168±7	0.957
Hemoglobin (g/dL)	13±1.5	13±1.8	0.533
Systolic BP (mmHg)	145±17	143±15	0.725
Diastolic BP (mmHg)	79±6	80±7	0.382
Heart rate (bpm)	75±9	73±11	0.677
Creatinine (mg/dL)	0.95. [4.8–0.5]	0.9. [1.5–0.6]	0.952
Ejection fraction	60. [65–40]	60. [65–30]	0.434
Heparin (IU)	9850±574	9931±371	0.524
Procedural time (min)	45±17	33±12	0.007
Contrast volume (cc)	257±109	170±58	0.001
TR band duration (min)	108±37	98±26	0.290
Clopidogrel	10 (32.3)	13 (41.9)	0.599
ASA	25 (80.6)	28 (90.3)	0.473
Beta-blocker	17 (54.8)	17 (54.8)	1.000
Calcium channel blocker	7 (22.6)	5 (16.1)	0.749
Statin	14 (45.2)	14 (45.2)	1.000
Nitrate	3 (9.7)	2 (6.5)	1.000
ACEI/ARB	20 (64.5)	18 (58.1)	0.795
RAS % (n)	16.7 (5)	31 (9)	0.233
RAO % (n)	10.7 (3)	11 (3)	1.000
Post-procedural pain % (n)	64.5 (20)	33.3 (10)	0.021

ACEI/ARB: Angiotensin converting enzyme inhibitor/angiotensin receptor blocker; ASA: Acetyl salicylic acid; BP: Blood pressure; bpm: beats per minute; IU: International unit; PAD: Peripheral artery disease; RAS: Radial artery spasm; RAO: Radial artery occlusion

erator moves the catheter or sheath or experiences difficulty in catheter movement (4, 5). The pathophysiology of RAS is not well understood, but basic science studies suggest a possible role for α -1-adrenoreceptor activation (6). Female gender, large sheath size, multiple catheter exchange, tortuosity, inexperienced operator, and excessive catheter manipulation were previously shown to be associated with RAS.

The transradial route has been recommended as the standard approach for both coronary angiography and PCI in recent guidelines (2). However, these guidelines did not give a recommendation regarding the impact of ad hoc or staged PCI for non-elective procedures on complications such as RAS or RAO. RAS incidence was reported as 1–30% in the literature, depending on operator

expertise and the definitions used for RAS (5, 7). The incidence of RAS was 23% in our total study population, which was consistent with the incidence in the literature.

Since the radial artery is a type III limb artery, it is more prone to spasm than larger arteries. As well as the size of the catheter, the sheath and radial artery diameter play a role in the development of RAS, and the patient's perception of pain during cannulation is also closely related with RAS (8). In a study of 637 patients, 90% of those suffering severe pain during transradial catheterization suffered RAS (9). Intraprocedural characteristics of the pain during transradial procedures are the key determinants of a clinical RAS diagnosis, but the number of punctures and the patient's anxiety level are also related to RAS (3, 10). In our study, although we did not detect any difference in RAS between the staged and ad hoc intervention groups, post-procedural pain was more common in the ad hoc group. Keeping increased procedural time in the ad hoc group in mind, the operator may prefer to use a staged approach for patients with severe pain during cannulation or diagnostic coronary angiography in order to avoid post-procedural pain. However, a preference for a staged approach in this group of patients does not seem to translate into avoidance of RAS, as implied by the present study.

In a study conducted by Galli et al., ad hoc transradial coronary angioplasty was compared with staged transfemoral PCI in 800 patients, and the transradial approach was shown to be safe, feasible, and more cost-effective than the transfemoral approach (11). However, this study did not focus on complications such as RAS (only 5 occurrences in 400 transradial procedures) and the main difference from our study was their comparison of an ad hoc transradial with a staged femoral approach. Similarly, in the landmark MATRIX trial that compared radial with femoral approaches in patients with acute coronary syndrome undergoing PCI, the radial approach was shown to be associated with reduced net adverse clinical events, all-cause mortality, and major bleeding (12). Although this was a cornerstone trial in the evolution of the transradial approach, RAS was not mentioned in this study. Therefore, there is an evidence gap in the setting of treatment for stable angina pectoris via a transradial route in methods to reduce the most common complication of radial approach, namely RAS. Interventionalists with radial approach expertise are quite familiar with the idea that the operator should aim for prevention of RAS rather than treatment.

The RADIAL-CABG study compared transradial and transfemoral approaches in patients with a history of CABG and found longer procedural times and greater use of contrast agents with transradial procedures (13). This finding was supported by other trials and meta-analyses, as the radial approach has a steep learning curve and is technically more challenging, and is therefore associated with greater radiation exposure and use of contrast agents (14, 15). Disadvantages of the radial approach, such as increased procedure time and contrast agent use, can be reduced by selection of a staged PCI strategy instead of ad hoc PCI in light of the present study. The AKI-MATRIX study reported decreased rates of acute kidney injury with transradial access compared with femoral access in patients suffering acute coronary syndrome (16). To the best of our knowledge, contrast agent use has not previously been investigated within the radial approach subgroups (ad hoc or staged strategy), and thus the present study may give rise to future studies

investigating prevention of acute kidney injury in patients undergoing elective transradial procedures.

Study Limitations

The main limitations of the present study are its retrospective design and relatively small sample size. Presence of RAS was not verified with angiographic images, although this is not mandatory. In the context of multiple factors suggested to be associated with RAS, several factors with potential RAS interaction were not included in our model, though we aimed to include the most common factors. Post-procedural pain assessment was not performed with a scale or questionnaire, so severity of the pain was not interpreted. Further studies are warranted to confirm the findings of our study in a prospective study design with a larger sample size.

CONCLUSION

Use of an ad hoc or staged strategy in patients undergoing transradial PCIs is not associated with reduced incidence of RAS. Post-procedural pain is more common in patients undergoing ad hoc PCI with radial access than in those undergoing a staged approach.

Ethics Committee Approval: The study was approved by the local ethical committee (Istanbul Medipol University Ethic Committee, approval date 27/11/2019, issue number 10840098-604.01.01-E.63381) and the study was carried out in accordance with the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – GGD, EG; Design – GGD; Supervision – EG; Data Collection and/or Processing – GGD, EG; Analysis and/or Interpretation – GGD; Literature Search – GGD; Writing – GGD; Critical Reviews – GGD, EG.

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

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

- Chugh SK, Chugh Y, Chugh S. How to tackle complications in radial procedures: Tip and tricks. *Indian Heart J* 2015; 67(3): 275–81.
- Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, et al; ESC Scientific Document Group. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J* 2019; 40(2): 87–165. [CrossRef]
- Jia DA, Zhou YJ, Shi DM, Liu YY, Wang JL, Liu XL, et al. Incidence and predictors of radial artery spasm during transradial coronary angiography and intervention. *Chin Med J (Engl)* 2010; 123(7): 843–7.
- Omaygenc MO, Karaca IO, Ibisoglu E, Günes HM, Kizilirmak F, Cakal B, et al. A novel predictor of radial spasm: arterial stiffness. *Blood Press Monit* 2018; 23(5): 253–9. [CrossRef]
- Ho HH, Jafary FH, Ong PJ. Radial artery spasm during transradial cardiac catheterization and percutaneous coronary intervention: incidence, predisposing factors, prevention, and management. *Cardiovasc Revasc Med* 2012; 13(3): 193–5. [CrossRef]
- He GW, Yang CQ. Characteristics of adrenoceptors in the human radial artery: clinical implications. *J Thorac Cardiovasc Surg* 1998; 115(5): 1136–41. [CrossRef]
- Tebaldi M, Biscaglia S, Tumscitz C, Del Franco A, Gallo F, Spitaleri G, et al. Comparison of Verapamil versus Heparin as Adjunctive Treatment for Transradial Coronary Procedures: The VERMUT Study. *Cardiology* 2018; 140(2): 74–82. [CrossRef]
- Curtis E, Fernandez R, Lee A. The effect of topical medications on radial artery spasm in patients undergoing transradial coronary procedures: a systematic review. *JBI Database System Rev Implement Rep* 2018; 16(3): 738–51. [CrossRef]
- Ruiz-Salmerón RJ, Mora R, Vélez-Gimón M, Ortiz J, Fernández C, Vidal B, et al. Radial artery spasm in transradial cardiac catheterization. Assessment of factors related to its occurrence, and of its consequences during follow-up. [Article in Spanish]. *Rev Esp Cardiol* 2005; 58(5): 504–11. [CrossRef]
- Ercan S, Unal A, Altunbas G, Kaya H, Davutoglu V, Yuce M, et al. Anxiety score as a risk factor for radial artery vasospasm during radial interventions: a pilot study. *Angiology* 2014; 65(1): 67–70. [CrossRef]
- Galli M, Di Tano G, Mameli S, Butti E, Politi A, Zerboni S, et al. Ad hoc transradial coronary angioplasty strategy: experience and results in a single centre. *Int J Cardiol* 2003; 92(2-3): 275–80. [CrossRef]
- Valgimigli M, Frigoli E, Leonardi S, Vranckx P, Rothenbühler M, Tebaldi M, et al. Radial versus femoral access and bivalirudin versus unfractionated heparin in invasively managed patients with acute coronary syndrome (MATRIX): final 1-year results of a multicentre, randomised controlled trial. *Lancet* 2018; 392(10150): 835–48. [CrossRef]
- Michael TT, Alomar M, Papayannis A, Mogabgab O, Patel VG, Rangan BV, et al. A randomized comparison of the transradial and transfemoral approaches for coronary artery bypass graft angiography and intervention: the RADIAL-CABG Trial (RADIAL Versus Femoral Access for Coronary Artery Bypass Graft Angiography and Intervention). *JACC Cardiovasc Interv* 2013; 6(11): 1138–44. [CrossRef]
- Georges JL, Belle L, Meunier L, Dechery T, Khalifé K, Pecheux M, et al; RAY'ACT Investigators. Radial versus femoral access for coronary angiography and intervention is associated with lower patient radiation exposure in high-radial-volume centres: Insights from the RAY'ACT-1 study. *Arch Cardiovasc Dis* 2017; 110(3): 179–87. [CrossRef]
- Ferrante G, Rao SV, Juni P, Da Costa BR, Reimers B, Condorelli G, et al. Radial Versus Femoral Access for Coronary Interventions Across the Entire Spectrum of Patients With Coronary Artery Disease: A Meta-Analysis of Randomized Trials. *JACC Cardiovasc Interv* 2016; 9(14): 1419–34. [CrossRef]
- Andò G, Cortese B, Russo F, Rothenbühler M, Frigoli E, Gargiulo G, et al; MATRIX Investigators. Acute Kidney Injury After Radial or Femoral Access for Invasive Acute Coronary Syndrome Management: AKI-MATRIX. *J Am Coll Cardiol*. 2017 May 11. doi: 10.1016/j.jacc.2017.02.070. [Epub ahead of print] [CrossRef]