# ORIGINAL ARTICLES

## INCIDENCE AND PREDICTORS OF RADIAL ARTERY SPASM DURING LEFT HEART CATHERIZATION

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## ABSTRACT

***Objective:*** To determine the incidence of radial artery spasm and various predictors leading to radial artery spasm during coronary angiography/angioplasty in Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi.
***Study Design:*** Cross sectional study.
***Place and Duration of Study:*** Department of Interventional Cardiology, Armed Forces Institute of Cardiology & National Institute of Heart Diseases Rawalpindi, from Aug to Nov 2020.
***Methodology:*** This study enrolled 272 patients who were to under go the procedure of coronary angiography/percutaneous coronary intervention either already admitted or came for out-patient procedure. Coronary angiography/percutaneous coronary intervention was done via trans radial approach and the study participants were observed for development of radial artery spasm. The patients were managed according to the department protocol.
***Results***: The frequency of radial artery spasm was 30 (11%). No statistically significant association was found between radial artery spasm and various predictors such as age, hypertension and diabetes mellitus ($p$>0.05), except female gender ($p$<0.05).
***Conclusion:*** Radial artery spasm is a common complication of trans radial approach for coronary angiography/percutaneous coronary intervention particularly in females undergoing the procedure.

**Keywords:** Angina, Coronary angiography, Myocardial infarction, NSTEMI, Percutaneous coronary intervention, Radial artery spasm, STEMI.



## INTRODUCTION

The process of cardiac catheterization was first demonstrated by German physician in 1929. Since then the process has changed and modified a lot and now it is one of the most frequently performed minimally invasive procedure which is used to detect and/or treat multiple cardiac issues.

One of the most important and crucial initial step is to gain access and insert a sheath in a peripheral artery so that a catheter can be introduced via this access into the coronary sinus. With the recent advancements in medical sciences and technologies, Trans-Radial access is a good alternative to trans femoral approach with less major vascular complications, increase patient's comfort and early mobilization and less hospital stay as compared to Trans-Femoral access[1,2].

Anatomically radial artery is a thick walled artery with concentric smooth muscles and is susceptible to spasm due to abundance of alpha1-receptors[3]. A study conducted in Turkey showed that radial artery spasm (RAS) in gaining the access or during the procedure proved to be a major hindrance in using this approach or switching the procedure to trans-femoral access[4]. They also concluded that female gender is an independent risk factor for RAS[4]. Another study concluded that RAS occurred in 33% of female population[2]. The only two predictors of RAS in this study were number of attempts of radial puncture and size of catheter used [2]. Another study showed that the RAS was more common in increasing age, females and hypertensives[4]. Many studies concluded that the incidence of radial artery spam in the study population was between 6-10%[4,5].

With regards to arterial access site, the femoral artery and radial artery are routinely selected. For patients in whom radial and femoral access is impossible, the brachial method is sometimes employed, though less desirable due to the risk of complications, including neuropathy[11,12]. Studies have shown that, compared with the femoral approach, the radial method has reduced bleeding risk, earlier hospital discharge, lower cost, reduced haematoma formation, lower mortality and morbidity, and is preferred by most patients[13-17]. In a study reported rates of RA occlusion vary greatly from 1-3% to up to 19.7% (temporary occlusion)[18]. Perforation or rupture of the artery is a rare complication that can lead to forearm haematoma. More serious complications, such as compartment syndrome, can occur. Pseudoaneurysm is an extremely rare

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complication in the RA approach (more common in transfemoral procedures) and occurs when an artery wall is injured, resulting in possible haemorrhage and haematoma in the surrounding tissue, However, it carries technical challenges, not least on account of the small RA diameter, which hinders instrument insertion and increases artery-instrument contact, heightening the risk of disruption to the endothelial surface, which increases the risk of spasm

The study is done to determine the frequency and major predictors of radial artery spasm during coronary angiography in our setup and to see whether the incidence can be reduced by using a proper technique or by carefully selecting the patients for coronary angiography via trans-radial approach.

## METHODOLOGY

This cross-sectional study was conducted at department of Interventional Cardiology Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi, from August to November 2020. Sample size of this study was calculated to be 272. This number was arrived at using the following: confidence level=95%: anticipated proportion of RAS=6%: absolute precision = 2.8%.

After approval by ethics committee of Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi, data was collected. All patients who were to go under the procedure of coronary angiography/PCI either already admitted or came for out-patient procedure were assessed.

All patients were explained the study in detail in the language they could understand and a written informed consent was taken from them along with a detailed history about any drugs usage or previous medical record. The initial standard 12 lead ECG, recorded immediately after the patient's admission and pre-procedural necessary investigations were assessed and were considered as baseline.

Allen's test for radial artery patency was performed on all the patients. All patients meeting the inclusion criteria had the procedure performed via transradial access. A cocktail of 1cc heparin and 1cc of IV nitrates were infused into the sheath passed into the radial artery before introducing the catheter. Continuous bedside monitoring was carried out and all the patients were closely observed for radial artery spam.

The operator assessed the radial spasm on the basis of a questionnaire addressing the following five signs: persistent forearm pain, pain response on catheter manipulation, pain response to introducer withdrawal, difficult catheter manipulation after being "trapped" by the radial artery with considerable resistance on withdrawal of the introducer. Radial spasm was considered to be indicated by the presence of at least 2 of these 5 signs or by the presence of just 1 when the operator considered it necessary to administer a second dose of the spasmolytic agent.

In addition to the presence of radial spasm, the following procedure-related variables were analyzed: Prior preparation with the topical anesthetic cream.

Pain intensity during radial artery cannulation (radial artery puncture and insertion of the introducer) as perceived by the patient. Pain was scored on a scale of 0 to 3 (0, absence of pain; 1, mild pain; 2, moderate pain; and 3, severe pain). In each case, the patient was asked to differentiate between the pain experienced during radial artery cannulation and that felt while catheterized (radial artery spasm).

Cannulation of the right or left radial artery. Type of procedure (diagnostic or diagnostic followed by an adhoc intervention. Length of the procedure, defined as the time elapsed between insertion of the introducer and its withdrawal. Total number of catheters employed (3 or less, or more than 3).

Initial and maximum diameters of the catheters employed, measured according to the French system. Radial artery spasm on basis of diameter of the radial artery was determined by angiography. For this purpose, the contrast agent was injected via the introducer before and 2 minutes after the administration of the vasodilator.

A 30-40mm long segment of the artery was selected for the determination of the mean diameter of the vessel using a computer-assisted quantification method (QUANTCOR, Siemens®). The distal portion of the introducer was used as a reference. With the aid of precise anatomical markers, the selected segment was measured under baseline conditions and after vasodilator administration. In addition to the mean diameters, we calculated the radial vasodilatory capacity using the following equation: postvasodilation diameter-baseline diameter/baseline diameter.

All measurements were performed by the same operator. Radial angiography also enabled us to detect the anatomic anomalies of this vessel. All these findings were systematically collected. All patients were separated in two defined groups group A (RAS+), patients having Radial artery spam and group B (RAS-),

patients having procedure without any spam following the procedure. Both groups were compared for different variables. All the study procedure and data collection was done by the trainee researcher and was recorded on a proforma.

Data was analysed using SPSS-20. Categorical variables like gender, presence of diabetes, hypertension, and presence of radial artery spams were described as frequencies and percentages. Quantitative variables like age were described as mean ± SD. Outcome variable i.e. Radial artery spams was stratified by age, gender, diabetes and hypertension. Post stratification Chi-square test was used at 5% level of significance.

## RESULTS

This descriptive cross sectional study enrolled 272 patients as per operational definitions and inclusion and exclusion criteria outlined above.

The frequency of radial artery spasm in this study was 11% as it was diagnosed in 30 study participants. The various quantitative and qualitative variables in this study are described below in (table I-V). When the outcome variable i.e., radial artery spasm was stratified by age, hypertension and diabetes mellitus, the results were statistically insignificant ($p$>0.05). When the outcome i.e, radial artery spasm was stratified by gender, a statistically significant association between the two was noted ($p$<0.05).

**Table-I: Age of study participants.**

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Age of patients | 53.95 | 10.29 | 26 | 80 |

**Table-II: Socio-demographic characteristics of study participant.**

| Variables | Frequency | Percentage |
|---|---|---|
| **Gender** | | |
| Male | 192 | 70.59 |
| Female | 80 | 29.42 |
| **Hypertension** | | |
| Yes | 166 | 61.03 |
| No | 106 | 38.97 |
| **Diabetes Mellitus** | | |
| Yes | 90 | 33.09 |
| No | 182 | 66.91 |
| **Radial Artery Spasm** | | |
| Yes | 30 | 11.00 |
| No | 242 | 89.00 |

**Table-IV: Cross tabulation of radial artery spasm with the sex of study participants.**

| Radial Artery Spasm | Sex | | Total | $p$-value |
|---|---|---|---|---|
| | Male | Female | | |
| Yes | 15 | 15 | 30 | 0.04 |
| No | 177 | 65 | 242 | |

*$p \leq 0.05$*

**Table-V: Cross tabulation of radial artery spasm with the frequency of diabetes mellitus in study participants.**

| Radial Artery Spasm | Diabetes Mellitus | | Total | $p$-value |
|---|---|---|---|---|
| | Yes | No | | |
| Yes | 7 | 23 | 30 | 0.61 |
| No | 83 | 159.00 | 242 | |

*$p \leq 0.05$*

**Table-VI: Cross tabulation of radial artery spasm with the frequency of hypertension in study participants**

| Radial Artery Spasm | Hypertension | | Total | $p$-value |
|---|---|---|---|---|
| | Yes | No | | |
| Yes | 24 | 12 | 72 | 0.59 |
| No | 142 | 94 | 236 | |

*$p \leq 0.05$*

The frequency of radial artery spasm in this study was 11% which is slightly higher than the reported frequency of radial artery spasm in literature[6,7]. There was no statistically significant association between radial artery spasm and known predictors such as diabetes, hypertension and age of patients, however a statistically significant association was found between gender and radial artery spasm in this study.

A study from China found a statistically significant association between radial artery spasm and a number of predictors such as age ($p$=0.038), female ($p$=0.026), small diameter of radial artery ($p$<0.001), diabetes ($p$=0.026), smoking ($p$=0.019), moderate or severe pain during radial artery cannulation ($p$<0.001), unsuccessful access at first attempt ($p$=0.002), big sheath ($p$=0.004), number of catheters (>3) ($p$=0.048), rapid baseline heart rate ($p$=0.032) and long operation time ($p$=0.021)[6]. In the same study, logistic regression showed that female (OR=1.745, 95%CI: 1.148-3.846, $p$=0.024), small radial artery diameter (OR=4.028, 95% CI: 1.264-12.196, $p$=0.008), diabetes (OR=2.148, 95%CI: 1.579-7.458, $p$=0.019) and unsuccessful access at first attempt (OR=1.468, 95% CI: 1.212-2.591, $p$=0.032) were independent predictors of RAS. Follow-up at (28 ± 7) days after the procedure showed that, compared with non-spasm patients, the RAS patients had higher portion of pain (11.8% vs. 6.2%, $p$=0.043). The occurrences of hematoma (7.3% vs. 5.6%, $p$=0.518) and radial artery occlusion (3.6% vs. 2.6%, $p$=0.534) were similar[6].

## DISCUSSION

On the other hand, another study reported that radial artery spasm was noted more in older patients, patients with hypertension, and also in female patients[7]. In this study from Turkey, The patients with spasm were older (mean age 63.9 ± 9.4 years vs. 60 ± 11.2 years, $p$<0.001) and more commonly female (51.3% vs. 34.4%, $p$<0.001). Spasm was more common in hypertensive patients (66% vs. 56%, $p$<0.009). Surprisingly, smoking was less common in patients with spasm (17% vs 29%, $p$<0.001). Multiple logistic regression analysis showed that female gender (OR=1,524, 95% CI: 1.033-2.248, $p$=0.034) was the only independent predictor of RAS at the beginning of the procedure[7].

A recent study from India reported a 26.3% frequency of radial artery spasm in study population[8].In this study, radial artery spasm was more common in female than male (44.96% vs 19.89%, $p$<0.001). Mean weight patients developing RAS 64.05 ± 11.99, mean BMI 25.43 ± 4.43, it was 65.51 ± 10.96 and 24.96 ± 3.81, respectively in contro ls ($p$=0.242). RAS patients mean height 158.74 ± 9.12 compared to 162.02 ± 8.82 in controls ($p$<0.001). Out of 34.6% diabetics and 23.5% non-diabetic developed RAS ($p$=0.013). Surprisingly, RAS occurred in 31.1% non smokers and 18.9% of smokers ($p$=0.002). Mean length of angiography in RAS patients 12.47 ± 7.10 min compared to 6.96 ± 3.16 min in controls ($p$<0.001). Patients requiring >1 attempt to cannulate 46.34% developed RAS ($p$<0.001). Mean pain score during cannulation in RAS 2.67 ± 1.47 vs 1.25 ± 0.86 in controls ($p$<0.001)[8]. The authors concluded that female sex, short height, small body surface area, diabetes, increase length of procedure >1 attempt to cannulate radial artery, intensity of pain during cannulation and >1 catheter use during angiography were predictors of radial artery spasm[8].

Another study reported that radial artery spasm was associated with the use of a larger arterial catheter[9]. In this study, A sample set of 415 patients, (66% male) with a mean age (± standard deviation) of 67.7 years ± 11.9 years was analysed and showed 25 cases (6%) of radial artery vasospasm. The rates of radial artery vasospasm was found to be more frequent in females (10%) than in males (4%) and in patients with an English-speaking background (7%). The data suggested that the prevalence of radial artery vasospasm was more common in patients with both treated and untreated hypertension (7%). Binary logistic regression confirmed that radial artery vasospasm was independently and significantly associated with the use of a French catheter during angiography ($p$=0.047, 95%CI 0.01-1.04)[9].

Another, fairly recent study from Bhopal India reported radial artery spasm in 26.3% patients. The study reported that female sex was an independent predictor of RAS with significant $p$-value<0.001. Radial artery spasm was smokers/non smokers was statistically significant ($p$=0.002), more common in diabetics and difference was statistically significant. Difference in alcoholics was not significant. Patients in whom >1 catheter/ single catheter, was statistically significant ($p$≤0.001)[10]. Left radial/right radial approach was not statistically significant ($p$=0.318). Mean pain score of patients which develop/which not radial artery spasm develop was statistically significant ($p$≤0.001). The mean duration and length of procedure to complete a transradial angiography in patients who develop RAS and who do not develop RAS was statistically significant ($p$ ≤0.001)[10].

A study also reveals that the use of the RA instead of the femoral artery has reduced complications at the time of coronary artery procedures. However, despite improvement in cannulation techniques, minimisation of sheath size, hydrophilic coatings and use of radial "cocktails" complications still occur, most commonly RA spasm, in a proportion of patients resulting is pain, procedural failure and RA damage[19].

This study did not consider many of the predictors of radial artery spasm, and of the few known predictors that were studied, only female sex was found to be significantly associated with radial artery spasm confirming earlier and other reports published in literature.

## LIMITATIONS OF STUDY

This was a single center based study with a small sample size, therefore the results need to be inter-preted with caution. Limited number of predictors affecting the frequency of radial artery spasm were studied.

## CONCLUSION

Radial artery spasm is a known complication of transradial approach for coronary angiography/angioplasty and is more commonly seen in female patients undergoing coronary angiography via transradial approach.

## CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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