Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

General Medicine

Relationship between Radial Artery Diameters with Incidence of Radial Artery Occlusion after Transradial Coronary Catheterization: An Observational Cohort Study

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DOI: https://doi.org/10.36347/sjams.2024.v12i11.035 | **Received:** 16.10.2024 | **Accepted:** 21.11.2024 | **Published:** 26.11.2024

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Abstract **Original Research Article**

***Background*:** Radial artery Occlusion (RAO) is a potential complication of transradial coronary catheterization procedures. The association between radial artery diameter and the risk of RAO remains controversial, with conflicting findings reported in previous studies. ***Objectives*:** To investigate the relationship between radial artery diameter with incidence of radial artery occlusion after transradial coronary catheterization and to assess the independent predictive value of radial artery diameter for RAO. ***Methods*:** This prospective, observational cohort study enrolled 300 patients undergoing transradial coronary angiography or percutaneous coronary intervention at a single center. Radial artery diameter was measured using a standardized ultrasound protocol before the procedure. Radial artery patency was assessed immediately after the procedure and at a 24-48 hour follow-up visit, with RAO defined as the absence of detectable blood flow on Doppler ultrasound. Multivariate logistic regression analysis was performed to evaluate the independent association between radial artery diameter and RAO, adjusting for potential confounders. ***Results*:** Radial artery occlusion occurred in 38 patients (12.7%). Patients with a small radial artery diameter (<2.5mm) had a significantly higher incidence of RAO (24.0%) compared to those with a larger radial artery diameter (6.7%) (p=0.003). On multivariate analysis, small radial artery diameter (OR 3.24, 95% CI: 1.52-6.91, p=0.002) and larger sheath size (OR 1.85 per 1 Fr increase, 95% CI: 1.21-2.83, p=0.005) were independent predictors of RAO. ***Conclusions*:** Smaller radial artery occlusion following transradial coronary catheterization procedures. Radial artery diameter is significantly associated with an increased risk of radial artery assessment may help identify patients at higher risk for RAO and guide personalized decision-making regarding vascular access site selection and procedural techniques.

Keywords: Radial Artery, Catheterization, Coronary Angiography, Percutaneous Coronary Intervention, Vascular Patency.

INTRODUCTION

The transradial approach for coronary catheterization and interventional procedures has gained widespread acceptance due to its numerous advantages over the traditional transfemoral approach, including reduced risk of access site complications, earlier patient ambulation, and increased patient comfort [1, 2]. However, one of the potential complications associated with the transradial approach is radial artery occlusion (RAO), which can occur in a significant proportion of patients and may compromise future use of the radial artery for vascular access [3, 4].

Radial artery occlusion is a multifactorial phenomenon, with several patient-related and procedural factors contributing to its development. Among these factors, the diameter of the radial artery has been proposed as a potential predictor of RAO risk [5, 6]. The radial artery is a small caliber vessel, and a smaller diameter may increase the likelihood of vessel injury, spasm, or thrombosis during catheter manipulation, potentially leading to occlusion [7].

Several studies have investigated the relationship between radial artery diameter and the incidence of RAO, but the results have been inconsistent [8, 9]. Accurate assessment of radial artery diameter is crucial in determining its potential role as a risk factor for RAO. Various methods have been used to measure radial artery diameter, including ultrasound, angiography, and Doppler techniques. Each method has its strengths and limitations, and the choice of

measurement technique may influence the results and their interpretation.

This study aims to investigate the correlation between radial artery diameter and the incidence of radial artery occlusion after transradial coronary catheterization. By employing a standardized and reliable method for measuring radial artery diameter, such as ultrasound or angiography, and following a well-defined protocol for assessing RAO, this research endeavors to provide valuable insights into the potential role of radial artery diameter as a predictor of RAO risk. The findings of this study may contribute to the development of risk stratification strategies and inform clinical decision-making regarding the selection of appropriate vascular access sites for coronary procedures.

METHODOLOGY

This was a prospective, observational cohort study conducted at S.Nijalingappa Medical College and Shri Hanagal Kumareshwar Hospital & Research Centre, Bagalkot, Karnataka, India. The study population consisted of consecutive patients undergoing transradial coronary angiography or percutatneous coronary intervention (PCI) at the institution's cardiac catheterization laboratory. Patients with a history of previous ipsilateral radial artery catheterization, anatomical variations of the radial artery, or concomitant peripheral artery disease involving the upper extremities were excluded.

The sample size calculation was based on previous studies and an expected radial artery occlusion (RAO) rate of 5-10%. A total of 150 patients were enrolled to detect a clinically significant difference in RAO rates between patients with smaller and larger radial artery diameters, with a power of 80% and a significance level of 0.05.

The radial artery diameter was measured using high-resolution vascular ultrasound by a trained technician before the procedure. A standardized protocol was followed, with measurements taken at a fixed distance from the radial styloid process on the wrist. Three measurements were obtained, and the average diameter was recorded.

Transradial coronary catheterization and PCI were performed using standard techniques by experienced operators. The choice of hydrophilic sheath size and catheter dimensions was left to the operator's discretion based on the procedural requirements and radial artery characteristics.

Radial artery patency was assessed using the same vascular ultrasound protocol immediately after the procedure and at a follow-up visit scheduled 24-48 hours later. Radial artery occlusion was defined as the absence of detectable blood flow in the radial artery on Doppler ultrasound examination.

In addition to radial artery diameter and patency, data on patient demographics, clinical characteristics, procedural details (sheath size, catheter dimensions, duration of the procedure), and post-procedural complication were collected.

Patients were stratified into groups based on radial artery diameter quartiles or tertiles. The incidence of RAO was compared between these groups using chi-square or Fisher's exact tests, as appropriate. Multivariate logistic regression analysis was performed to assess the independent association between radial artery diameter and RAO, adjusting for potential confounding factors such as age, gender, body mass index, and procedural characteristics.

RESULTS

In our study, patients were stratified into small and large radial artery diameter (RAD) groups based on the median RAD of 2.5 mm. The baseline characteristics (Table 1) showed that patients with smaller RAD were older and had a lower proportion of males compared to those with larger RAD.

Table 1: Baseline Characteristics

Characteristic	Overall (n=150)	Small RAD* (n=75)	Large RAD* (n=75)	p-value
Age (years)	62.5 ± 11.2	64.1 ± 10.8	60.2 ± 11.5	**0.034**
Male	187 (62.3%)	41 (54.7%)	53 (70.7%)	**0.04**
Female	113 (37.7%)	33 (44%)	47(62.7%)	0.023
Diabetes	105 (35.0%)	31 (41.3%)	22 (29.3%)	0.12
Radial Artery Diameter (mm)	2.6 ± 0.4	2.1 ± 0.2	3.1 ± 0.3	**<0.001**

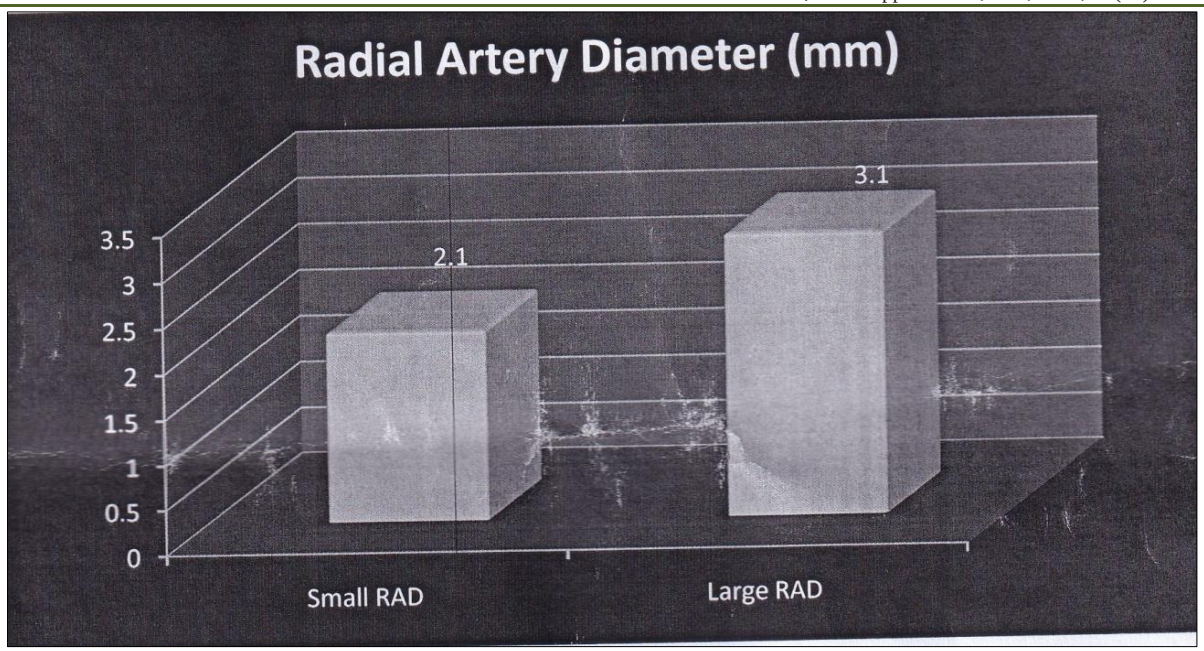

Figure 1: Bar-chart showing mean radial artery diameter among small and large RAD groups

Procedural characteristics (Table 2) revealed that patients with smaller RAD had smaller sheath size used during the procedure as expected, but there was no significant difference in procedure duration between the two groups.

Table 2: Baseline Characteristics

Characteristic	Overall (n=150)	Small RAD* (n=75)	Large RAD* (n=75)	p-value
PCI	198 (66.0%)	52 (69.3%)	46 (61.3%)	0.29
Sheath Size (Fr)	5.8 ± 0.6	5.6 ± 0.5	6.1 ± 0.5	**<0.001**
Procedure Duration (min)	42.2 ± 19.7	45.1 ± 21.3	39.8 ± 17.6	0.07

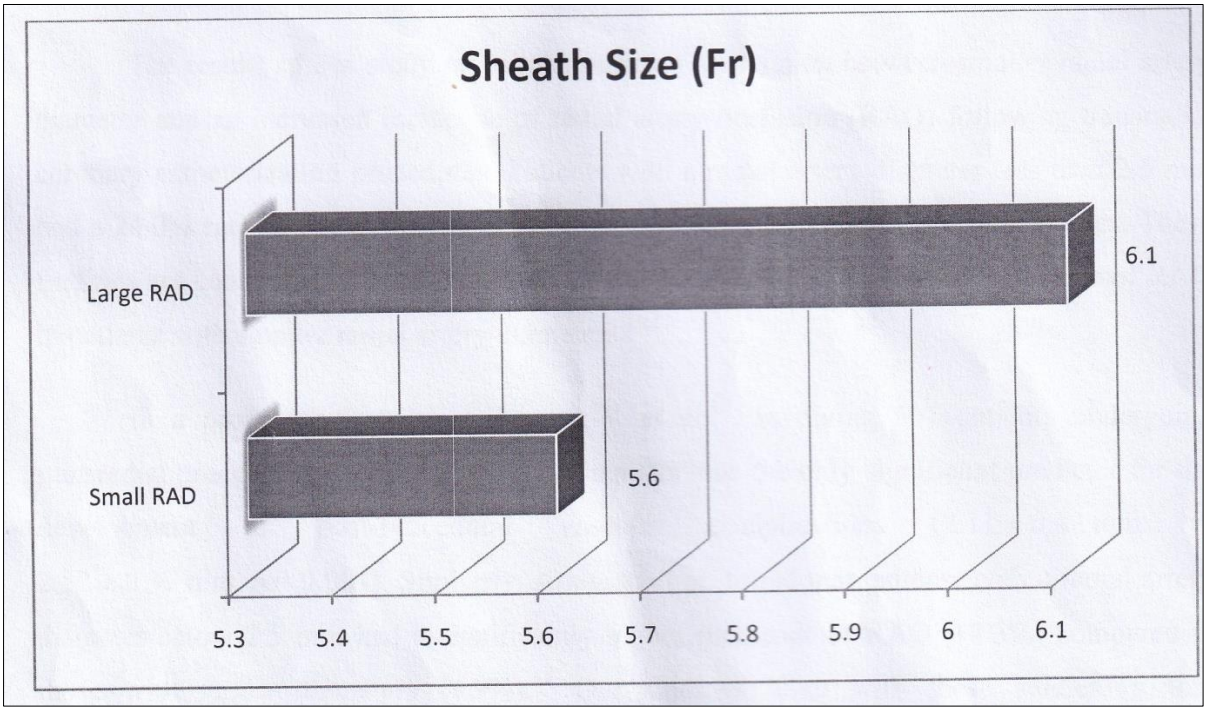

Figure 2: Bar chart showing Sheath Size (Fr) among small and large RAD groups

The key outcome, radial artery occlusion (RAO), was significantly higher in the small RAD group (24.0%) compared to the large RAD group (6.7%) as shown in Table 3.

Table 3: Radial Artery Occlusion Rates

Characteristic	Overall (n=150)	Small RAD* (n=75)	Large RAD* (n=75)	p-value
RAO	38 (12.7%)	18 (24.0%)	5 (6.7%)	**0.003**

Multivariate logistic regression analysis (Table 4) demonstrated that a small radial artery diameter (<2.5 mm) was an independent predictor of radial artery occlusion, with an adjusted odds ratio of 3.24 (95% CI: 1.52-6.91, p=0.002). Additionally, larger sheath size was also associated with a higher risk of RAO.

Table 4: Multivariate Analysis for Predictors of Radial Artery Occlusion

Variable	Odds Ration (95% CI)	p-value
Small Radial Artery Diameter (<2.5 mm)	3.24 (1.52-6.91)	**0.002**
Age (per 10-year increase)	1.18 (0.88-1.57)	0.27
Female Gender	1.62 (0.79 -3.31)	0.19
Diabetes	1.07 (0.51-2-24)	0.86
Sheath Size (per 1 Fr increase)	1.85 (1.21-2.83)	**0.005**
Procedure Duration (per 30 min increase)	1.34 (0.92-1.95)	0.13

DISCUSSION

The results of our study reveal a significant association between smaller radial artery diameter and an increased incidence of radial artery occlusion (RAO) following transradial coronary catheterization procedures. Patients with a radial artery diameter less than 2.5 mm had a 24.0% rate of RAO, compared to only 6.7% in those with larger radial arteries. These findings are consistent with several studies that have reported a higher risk of RAO in patients with smaller radial artery diameters [10, 11].

In a prospective study by Mattea V *et al*., [10], involving 507 patients undergoing transradial procedures, small radial artery diameter was the only significant predictor for the development of post-procedural vascular complications (2.11± 0.42mm vs 2.52 ± 0.39 mm, p=0.001) Similarly, Aminian *et al*., found that patients with a radial artery diameter below 2.5 mm had a significantly higher incident of RAO (18.3%) compared to those with larger diameters (4.9%) [11]. Our findings align with these studies, further reinforcing the importance of radial artery diameter as a risk factor for RAO.

However, it is important to note that not all studies have consistently demonstrated a significant association between radial artery diameter and RAO risk. According to Yoo *et al*., [12], women's mean radial artery inner diameter was 2.43±0.38 mm and men's was 2.69±0.40 mm. The radial artery diameter of 32% of men and 60% of women in that study was less than the outer diameter of a 6F sheath, which has an outside diameter of 2.52 mm. According to a Japanese study [13], the percentage of the radial artery that had a major reduction in blood flow was 13% when the outer sheath diameter was greater than the inner artery diameter and 4% when it was smaller (P=0.01). The authors suggested that factors such as sheath size, catheter dimensions, and operator experience might play a more critical role in determining RAO risk compared to radial artery diameter alone.

Our study addressed some of the limitations of previous research by employing a standardized ultrasound protocol for radial artery diameter measurement and a well-defined follow-up protocol for assessing RAO. Additionally, we adjusted for potential confounding factors, including sheath size and procedure duration, in our multivariate analysis. The independent association between smaller radial artery diameter and RAO risk persisted even after accounting for these procedural variables, lending further credence to our findings.

It is noteworthy that larger sheath sizes were also associated with a higher risk of RAO in our study, consistent with previous literature [3, 4]. This emphasizes the importance of careful sheath size selection, particularly in patients with smaller radial artery diameters, to minimize the risk of vascular complications.

While our study provides valuable insights into the relationship between radial artery diameter and RAO, it is essential to interpret these findings in the contest of the study's limitations, such as the single-centre design and the potential for operator variability in radial artery diameter measurement and procedural techniques. Future multicentre studies with larger sample sizes and standardized protocols are warranted to further elucidate the role of radial artery diameter in predicting RAO risk and do develop risk stratification strategies for patients undergoing transradial procedures.

CONCLUSION

This prospective, observational study demonstrates a significant correlation between smaller radial artery diameter and an increased incidence of radial artery occlusion following transradial coronary catheterization procedures. Patients with a radial artery diameter less than 2.5 mm were found to have a substantially higher rate of radial artery occlusion compared to those with larger radial artery diameters, even after adjusting for potential confounding factors such as sheath size and procedure duration. These findings suggest that radial artery diameter assessment, using a standardized protocol, may serve as a valuable tool for risk stratification and personalized decision-making in patients undergoing transradial procedures. By identifying patients at higher risk for radial artery occlusion, appropriate measures can be taken to mitigate this risk, such as selective use of smaller sheath sizes or consideration of alternative vascular access sites. While larger multicenter studies are warranted to further validate these results, our study highlights the importance of considering radial artery diameter as a predictor of radial artery occlusion and reinforces the need for meticulous procedural techniques, particularly in patients with smaller radial artery calibers.

Conflict of Interest: NIL

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