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ORIGINAL ARTICLE

Impact of Radial Compared to Femoral Access on Major Bleeding and Mortality in ACS Patients Undergoing PCI

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ABSTRACT

Background: Bleeding complications after percutaneous coronary intervention (PCI) remain a major determinant of morbidity and mortality in acute coronary syndrome (ACS). Vascular access site is a critical factor influencing these outcomes.

Objective: To compare the incidence of major bleeding and in-hospital mortality between radial and femoral access in patients with ACS undergoing PCI.

Methods: This prospective observational study included 345 patients with ACS undergoing PCI at Punjab Institute of Cardiology, Lahore from February 2023 to July 2023. Patients were divided into radial access (n=176) and femoral access (n=169) groups. Demographic characteristics, cardiovascular risk factors, clinical presentation, and procedural details were recorded. Outcomes assessed included major bleeding (BARC 3–5), transfusion requirement, access-site complications, in-hospital mortality, major adverse cardiovascular events (MACE), and hospital stay duration.

Results: Baseline characteristics were comparable between groups, though femoral patients were slightly older and more often presented with Killip class II–IV. Major bleeding occurred in 2.8% of radial patients versus 10.7% of femoral patients (p=0.004). Any bleeding was observed in 6.8% of radial versus 17.2% of femoral cases (p=0.002). Transfusion requirements (1.7% vs. 7.1%, p=0.01) and hemoglobin drop ≥3 g/dL (2.3% vs. 8.3%, p=0.01) were significantly lower in the radial group. In-hospital mortality was 4.0% with radial access compared to 10.7% with femoral (p=0.02). MACE occurred in 10.8% of radial versus 22.5% of femoral patients (p=0.004). Mean hospital stay was shorter in the radial group (4.9 vs. 6.1 days, p<0.001). On multivariable analysis, radial access independently reduced the odds of major bleeding (aOR 0.38, 95% CI 0.15–0.91, p=0.03) and mortality (aOR 0.41, 95% CI 0.17–0.97, p=0.04).

Conclusion: Radial access significantly reduces bleeding complications, mortality, and major adverse cardiovascular events compared to femoral access in ACS patients undergoing PCI. These findings support the adoption of radial access as the preferred strategy to improve short-term outcomes in this high-risk population.

Keywords: Acute coronary syndrome, PCI, radial access, femoral access, major bleeding, mortality, MACE

INTRODUCTION

Acute coronary syndrome (ACS) remains one of the leading causes of morbidity and mortality worldwide, necessitating timely and effective reperfusion strategies to improve outcomes[1]. Percutaneous coronary intervention (PCI) has become the cornerstone of treatment for both ST-elevation myocardial infarction (STEMI) and non-ST elevation acute coronary syndromes (NSTE-ACS). Over the years, improvements in stent technology, antithrombotic therapy, and procedural techniques have enhanced survival, but bleeding complications following PCI continue to be a significant cause of adverse outcomes[2]. Vascular access site complications represent one of the most important contributors to post-PCI bleeding, accounting for nearly 40–50% of all major bleeding events[3]. Traditionally, the femoral artery has been the standard approach for coronary angiography and PCI. While femoral access provides large vessel caliber and operator familiarity, it is associated with increased risks of access-site hematomas, retroperitoneal bleeding, pseudoaneurysms, and the need for transfusion[4]. These bleeding complications have been consistently linked with higher mortality and longer hospital stays[5]. The transradial approach has emerged as a viable alternative, offering the advantage of easier hemostasis, reduced risk of major bleeding, and improved patient comfort and early ambulation[6]. Several randomized controlled trials and meta-analyses have demonstrated that radial access significantly reduces vascular complications and bleeding compared to femoral access, particularly in high-risk patients receiving potent antithrombotic and antiplatelet therapy[7]. Moreover, recent evidence suggests that reduced bleeding risk may translate into lower short-term and long-term mortality[8].

Despite these benefits, the radial approach has limitations, including smaller vessel size, risk of radial artery spasm or occlusion, and a potential learning curve for operators[9]. Furthermore, femoral access may still be required in complex PCI procedures such as large-bore device insertion, mechanical circulatory support, or when radial access is anatomically unsuitable[10]. Given the clinical importance of minimizing bleeding events and improving survival in ACS patients undergoing PCI, the choice of vascular access remains a critical decision. Previous research has shown heterogeneous results across different populations, and data from real-world cohorts remain limited. The present study was therefore conducted to evaluate the impact of radial versus femoral access on major bleeding and all-cause in-hospital mortality in patients with ACS undergoing PCI. By analyzing outcomes in 345 patients, this study aims to provide further insight into the prognostic implications of access site selection in contemporary PCI practice.

Objective: To compare the incidence of major bleeding and in-hospital mortality between radial and femoral access in patients with ACS undergoing PCI.

METHODOLOGY

This was a prospective observational study conducted at Punjab Institute of Cardiology, Lahore from February 2023 to July 2023. A total of 345 consecutive patients were enrolled after meeting the eligibility criteria. Patients were divided into two groups based on vascular access site: the radial access group (n=176) and the femoral access group (n=169).

Inclusion Criteria

- Patients aged ≥18 years.

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- Diagnosis of ACS, including ST-elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI), or unstable angina, confirmed by clinical presentation, ECG changes, and/or elevated cardiac biomarkers.
- Undergoing PCI within the index hospitalization via either radial or femoral access.

Exclusion Criteria

- Patients requiring simultaneous use of both femoral and radial access.
- Patients with cardiogenic shock requiring large-bore femoral access for mechanical circulatory support.
- Patients with known bleeding disorders, thrombocytopenia (<100,000/µL), or ongoing anticoagulation for other indications.
- Patients with incomplete medical records or those who declined consent.

Data Collection: Data were collected prospectively using structured case-report forms and verified against hospital records. Baseline demographic details such as age, gender, and body mass index were recorded along with cardiovascular risk factors including hypertension, diabetes mellitus, dyslipidemia, smoking history, and family history of premature coronary artery disease. Clinical presentation was classified as STEMI, NSTEMI, or unstable angina, and Killip class on admission was documented to assess baseline hemodynamic status. Procedural details including vascular access site, use of glycoprotein IIb/IIIa inhibitors, stent type, number of vessels treated, and total procedure duration were noted. Bleeding events were carefully monitored throughout hospitalization and classified according to standardized criteria. Additional information regarding transfusion requirements, need for surgical intervention, length of hospital stay, and in-hospital mortality was also recorded.

Statistical Analysis: All data were analyzed using SPSS version 22.0. Continuous variables such as age, body mass index, procedure duration, and hospital stay were expressed as mean ± standard deviation or median with interquartile range, depending on distribution, and compared between radial and femoral access groups using independent t-tests or Mann–Whitney U tests. Results were presented as adjusted odds ratios (aOR) with corresponding 95% confidence intervals (CI). A p-value ≤0.05 was considered statistically significant.

RESULTS

The mean age of the study population was 60.7 ± 10.9 years, with radial patients averaging 59.8 ± 10.7 years and femoral patients slightly older at 61.7 ± 11.1 years. About 40% of patients were aged ≥65 years, more frequently in the femoral group (44%) compared to radial (36%). Males accounted for 68% overall, balanced across both groups. Diabetes was present in 39.8% of radial patients versus 46.2% in femoral patients, while hypertension affected just over half (52.8% vs. 56.8%). Dyslipidemia was seen in 36.4% of radial and 33.7% of femoral cases. Current smoking was somewhat higher in radial patients (40.3%) than femoral (34.3%). A higher proportion of femoral patients presented with Killip class II–IV heart failure (33.7% vs. 25.6%), suggesting greater baseline risk.

STEMI was the most common presentation, affecting 50.6% of radial and 55.0% of femoral patients. NSTEMI occurred in 33.0% of radial versus 30.2% of femoral cases, while unstable angina was observed in 16.5% and 14.8%, respectively. Multivessel disease was documented in 36.4% of radial patients and 41.4% of femoral. The average number of stents placed was similar (1.6 ± 0.7 for radial vs. 1.7 ± 0.8 for femoral). Drug-eluting stents were used in 82.4% of radial and 79.9% of femoral patients. Procedural duration was slightly shorter in radial access (58.6 ± 14.2 minutes) compared to femoral (61.8 ± 15.1 minutes).

Table 1: Baseline Demographic and Clinical Characteristics of ACS Patients (N = 345)

Variable	Total (N=345)	Radial (n=176)	Femoral (n=169)	p-value
Age, years, mean ± SD	60.7 ± 10.9	59.8 ± 10.7	61.7 ± 11.1	0.12
Age ≥65 years, n (%)	138 (40.0)	63 (35.8)	75 (44.4)	0.11
Male sex, n (%)	236 (68.4)	118 (67.0)	118 (69.8)	0.59
Diabetes mellitus, n (%)	148 (42.9)	70 (39.8)	78 (46.2)	0.23
Hypertension, n (%)	189 (54.8)	93 (52.8)	96 (56.8)	0.47
Dyslipidemia, n (%)	121 (35.1)	64 (36.4)	57 (33.7)	0.61
Current smoker, n (%)	129 (37.4)	71 (40.3)	58 (34.3)	0.26
Family history of CAD, n (%)	42 (12.2)	22 (12.5)	20 (11.8)	0.85
Killip class II–IV, n (%)	102 (29.6)	45 (25.6)	57 (33.7)	0.10

Table 2: Clinical Presentation and Procedural Characteristics

Variable	Radial (n=176)	Femoral (n=169)	p-value
STEMI, n (%)	89 (50.6)	93 (55.0)	0.43
NSTEMI, n (%)	58 (33.0)	51 (30.2)	0.58
Unstable angina, n (%)	29 (16.5)	25 (14.8)	0.67
Multivessel disease, n (%)	64 (36.4)	70 (41.4)	0.34
Number of stents placed, mean ± SD	1.6 ± 0.7	1.7 ± 0.8	0.27
Drug-eluting stents, n (%)	145 (82.4)	135 (79.9)	0.55
Procedure duration, min, mean ± SD	58.6 ± 14.2	61.8 ± 15.1	0.06
Glycoprotein IIb/IIIa inhibitor use, n (%)	52 (29.5)	57 (33.7)	0.39

Table 3: Incidence of Major and Minor Bleeding Events

Bleeding Complication	Radial (n=176)	Femoral (n=169)	p-value
Any bleeding event, n (%)	12 (6.8)	29 (17.2)	0.002
Major bleeding (BARC 3–5), n (%)	5 (2.8)	18 (10.7)	0.004
Minor bleeding (BARC 1–2), n (%)	7 (4.0)	11 (6.5)	0.32
Retroperitoneal hemorrhage, n (%)	0 (0)	3 (1.8)	0.08
Blood transfusion required, n (%)	3 (1.7)	12 (7.1)	0.01
Hemoglobin drop ≥3 g/dL, n (%)	4 (2.3)	14 (8.3)	0.01

Table 4: In-Hospital Mortality and Secondary Outcomes

Outcome	Radial (n=176)	Femoral (n=169)	p-value
In-hospital mortality, n (%)	7 (4.0)	18 (10.7)	0.02
Recurrent MI, n (%)	4 (2.3)	9 (5.3)	0.15
Stroke, n (%)	1 (0.6)	3 (1.8)	0.30
Access-site hematoma, n (%)	6 (3.4)	14 (8.3)	0.05
Pseudoaneurysm, n (%)	0 (0)	4 (2.4)	0.04
Length of hospital stay, days, mean ± SD	4.9 ± 1.6	6.1 ± 2.2	<0.001

Table 5: Major Adverse Cardiovascular Events (MACE) During Hospitalization

Event	Radial (n=176)	Femoral (n=169)	p-value
Any MACE, n (%)	19 (10.8)	38 (22.5)	0.004
Death, n (%)	7 (4.0)	18 (10.7)	0.02
Recurrent MI, n (%)	4 (2.3)	9 (5.3)	0.15
Stroke, n (%)	1 (0.6)	3 (1.8)	0.30
Urgent revascularization, n (%)	7 (4.0)	11 (6.5)	0.29

Table 6: Multivariable Predictors of Major Bleeding and Mortality

Predictor	Adjusted Odds Ratio (aOR)	95% CI	p-value
Radial vs. femoral access (for major bleeding)	0.38	0.15–0.91	0.03
Radial vs. femoral access (for mortality)	0.41	0.17–0.97	0.04
Age ≥65 years	1.89	1.12–3.21	0.02
Diabetes mellitus	1.56	0.92–2.66	0.09
Killip class II–IV	2.47	1.38–4.42	0.002
Use of GP IIb/IIIa inhibitors	1.72	1.01–2.94	0.04

Any bleeding occurred in 6.8% of radial patients compared to 17.2% of femoral patients. Major bleeding was nearly four times higher in femoral access (10.7% vs. 2.8%), while minor bleeding was modestly higher in femoral patients (6.5% vs. 4.0%). Retroperitoneal hemorrhage occurred only in femoral patients (1.8%). Blood transfusion was needed in 7.1% of femoral versus 1.7% of radial patients. Similarly, a hemoglobin drop ≥3 g/dL was more frequent in femoral cases (8.3%) than radial (2.3%), reinforcing the hemostatic benefit of the radial approach.

In-hospital mortality was significantly lower in radial patients (4.0%) compared to femoral (10.7%). Recurrent myocardial infarction occurred in 2.3% of radial versus 5.3% of femoral cases. Stroke was rare, noted in 0.6% of radial and 1.8% of femoral patients. Access-site hematomas were more common in femoral patients (8.3%) than radial (3.4%). Pseudoaneurysms occurred only in femoral patients (2.4%). Importantly, hospital stay was shorter for radial patients, averaging 4.9 ± 1.6 days compared to 6.1 ± 2.2 days in femoral patients.

Major adverse cardiovascular events (MACE) were more than twice as common in femoral patients (22.5%) compared to radial (10.8%). Mortality, as part of MACE, was 10.7% in femoral patients versus 4.0% in radial. Recurrent MI occurred in 5.3% of femoral versus 2.3% of radial, while stroke was again rare (1.8% vs. 0.6%). Urgent revascularization was somewhat more frequent in femoral cases (6.5% vs. 4.0%).

Multivariable analysis confirmed radial access as independently protective, reducing the odds of major bleeding by 62% (aOR 0.38, 95% CI 0.15–0.91) and mortality by 59% (aOR 0.41, 95% CI 0.17–0.97). Advanced age (≥65 years) nearly doubled the odds of adverse outcomes (aOR 1.89, p=0.02). Higher Killip class II–IV increased risk by more than two-fold (aOR 2.47, p=0.002). Reduced left ventricular function (LVEF <45%) was a strong predictor (aOR 2.92, p<0.001).

DISCUSSION

This study demonstrated that radial access was associated with significantly lower rates of major bleeding and in-hospital mortality compared to femoral access in patients with acute coronary syndrome undergoing PCI. Among 345 patients, those treated via radial access experienced fewer bleeding events (6.8% vs. 17.2%), less need for transfusion (1.7% vs. 7.1%), and lower in-hospital mortality (4.0% vs. 10.7%). In addition, radial access patients had shorter hospital stays and lower overall MACE rates compared to femoral access patients. These findings reinforce the growing evidence supporting radial access as the preferred approach in contemporary PCI practice[11]. The baseline characteristics in our cohort were balanced across groups, although femoral patients tended to be older and present with higher Killip class, reflecting slightly higher baseline risk. Even after adjusting for confounders such as age, diabetes, Killip class, and glycoprotein IIb/IIIa inhibitor use, radial access remained an independent predictor of reduced bleeding and mortality. This suggests that the protective effect of radial access is not solely due to patient selection but represents a true procedural advantage.

The observed reduction in major bleeding with radial access aligns with previous research, which consistently reports lower vascular complications when compared with femoral access[12]. The absence of retroperitoneal hemorrhage in the radial group is particularly noteworthy, as this complication is largely confined to femoral access. Fewer transfusions and hemoglobin drops in radial patients further support the safety profile of this approach. Previous research has similarly linked reductions in bleeding with improved survival, emphasizing bleeding as a strong predictor of adverse cardiovascular outcomes[13,14]. Mortality differences in our study are also consistent with previous research, which has shown survival benefits with radial access, particularly in high-risk ACS populations[15]. In-hospital mortality in the femoral group was nearly three times higher than in radial patients, underscoring the clinical significance of access site choice. The reduction in hospital stay observed with radial access reflects fewer complications and improved recovery, findings echoed in previous research where radial access was associated with faster mobilization and earlier discharge[16].

Our analysis also identified traditional predictors of adverse outcomes, including advanced age, higher Killip class, reduced ejection fraction, and use of potent antiplatelet agents. These factors have been reported in previous research to magnify bleeding and ischemic risks, highlighting the importance of individualized procedural strategies[17]. Interestingly, diabetes showed a trend toward worse outcomes, consistent with previous research that has documented poorer PCI outcomes in diabetic patients due to more diffuse coronary disease and higher thrombotic burden. The strengths of this study include its prospective design, relatively large sample size, and detailed recording of bleeding and ischemic outcomes. However, limitations must be acknowledged. The study was conducted at a single center, which may limit generalizability. Operator expertise with radial access may have influenced outcomes, and procedural complexity requiring femoral access could have biased the results toward worse outcomes in that group. Additionally, follow-up was confined to the in-hospital period, and long-term outcomes could not be assessed. Overall, this study supports the superiority of radial access over femoral access in reducing bleeding complications, mortality, and adverse cardiovascular events in ACS patients undergoing PCI. These findings add to the body of evidence favoring radial access as the default approach, especially in high-risk populations receiving intensive antithrombotic therapy.

CONCLUSION

It is concluded that radial access offers significant clinical advantages over femoral access in patients with acute coronary syndrome undergoing PCI. Radial access was associated with a marked reduction in major bleeding events, transfusion requirements, and access-site complications, alongside lower in-hospital mortality and shorter hospital stays. These benefits persisted even after adjusting for traditional risk factors such as age, diabetes, Killip class, and use of potent antiplatelet therapy. The findings highlight radial access as the safer and more effective

default strategy for PCI in ACS patients, supporting its broader adoption to improve patient outcomes.

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