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Assessment Of Complications in Radial Versus Femoral Access-Site for Coronary Interventions: A Comparative Study

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Abstract

Background: Trans radial access is becoming more popular internationally due to its decreased risk of access-site complications. However, many interventional cardiologists continue to choose the femoral route for coronary angiography and angioplasty in various coronary intervention procedures.

Objectives: To compare the overall rate of any access-site problems between radial and femoral methods.

Material and Methods: A prospective comparative cohort study was conducted from November 1st, 2025, to April 30th, 2026, at Rehman Medical Institute (RMI), a tertiary care cardiovascular hospital. In total, 132 adult subjects with either stable angina or acute coronary syndrome who needed coronary interventions for their complex coronary conditions were recruited and

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divided into two equal groups of radials (n=66) and femoral (n=66). Data were analyzed using the Chi-square test and the independent sample t-test.

Results: A total of 132 patients were analyzed (66 radial, 66 femoral). The two groups were comparable in mean age (57.93 ± 14.82 vs. 52.21 ± 23.97 years; p = 0.102). A highly significant association was found between access site and type of complication (χ^2 = 48.126, df = 8, p < 0.001). Overall, 22 radial patients (33.3%) and 38 femoral patients (57.5%) experienced at least one access-site complication, confirming a significantly higher complication burden in the femoral group. For the femoral cohort, hematoma constituted the most common problem (n = 24; 36.4%); on the other hand, radial artery spasm was the most common problem in the radial group (n = 14; 21.2%). Serious complications including retroperitoneal haemorrhage (n = 2), AV fistula (n = 2), and pseudoaneurysm (n = 4) occurred exclusively in the femoral group and were completely absent in the radial cohort.

Conclusion: Radial access is associated with significantly fewer and less severe access-site complications compared to femoral access in patients undergoing coronary interventions at tertiary care hospitals in Peshawar. The null hypothesis is rejected, confirming a statistically and clinically significant difference in complication profiles between the two access routes (χ^2 = 48.126, p < 0.001). The findings support consideration of a radial-first approach for interventional cardiology practice in this setting, supported by structured operator training in transradial technique across KPK cardiac centers.

INTRODUCTION

The heart is a muscular organ situated in the chest cavity, between the lungs and above the diaphragm, enclosed in a strong fibrous sac known as the pericardium. It has two atria, two ventricles, and four chambers (1). The heart comprises three layers or tunics. The innermost layer known as endocardium is a single layer of flat squamous type of endothelial cells on a very thin layer of connective tissue which contains elastic fibers, collagenous fibers, and some smooth muscles. The endocardium ensures that there is no obstruction to the passage of blood in the heart chambers. The myocardium is the deepest layer of the heart and is made up of cardiac muscle cells in a spiral manner surrounding the heart chambers (2).

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The heart is a mechanical pump that allows blood to circulate throughout the body (3). The heart muscle requires blood flow to function properly. Coronary arteries are responsible for this flow. The innermost tunica referred to as endocardium is made up of one layer of squamous cells called endothelium that sits on top of a very thin layer of connective tissue that has elastic fibers, collagen fibers, and some smooth muscle fibers. Endocardium acts as the smooth lining on the walls of heart chambers, which allows for blood to flow through the heart without obstruction (4). The occlusion of these vessels results in the development of coronary artery disease.

The chief etiologies of CVD are coronary artery disease (CAD), atherosclerosis, and arterial hypertension (AH) (5). The CVD epidemic is of greatest importance in Asia, amounting to 60% of the total 18.6 million cardiovascular (CV) fatalities documented worldwide in 2019. By 2050, the crude prevalence of CVDs in Asia is projected to reach 729.5 million, a 109.0% increase from 2025. IHD (338.0 million cases), PAD (151.0 million cases) and stroke (144.3 million cases) will be the top 3 most prevalent CVD subtypes, accounting for 86.8% of CVDs in the region by 2050 (6).

Coronary artery disorders are major contributors to human death and disease (7). CAD can be viewed as one of the key causes of heart disease, which encompasses mild to serious illnesses. CAD develops gradually, and there is a clear correlation between CAD and risk factors like high blood pressure, diabetes, high cholesterol, smoking, obesity, and lack of physical activity (8).

Coronary artery disease has traditionally been conceptualized as epicardial coronary artery occlusion, resulting in myocardial ischaemia, characterized by an imbalance between myocardial blood supply and demand. Coronary atherosclerosis progresses gradually, although plaque buildup is not linear; it may experience phases of rapid advancement or sudden instability, which can either resolve spontaneously or result in an acute clinical crisis. Guidelines have been produced to consider various entities of preventive and acute and chronic coronary syndromes (9).

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The acronym "acute coronary syndrome" describes a variety of disorders associated with the emergence of novel ischemia-related symptoms, from non-ST segment elevation myocardial infarction (NSTEMI) to unstable angina (10). NSTEMI comprises a range of clinical symptoms. Although they differ in severity, ST-segment elevation myocardial infarction (STEMI), unstable angina, and non-ST elevation myocardial infarction (NSTEMI) are closely related conditions with comparable pathophysiological causes and clinical manifestations (11). The diagnosis of acute coronary syndrome is based on clinical presentation, ECG abnormalities, and biochemical evidence of myocardial damage. The appropriate time of catheterisation in NSTEACS continues to be discussed. Principally, timing depends on clinical risk stratification. For patients at high risk, including unstable hemodynamics, non-responsive chest pain, and potentially lethal arrhythmias, urgent coronary angiography is indicated. Patients at high risk (GRACE > 140) undergo catheterization, while those with low risk utilize selective invasivity (12).

A crucial treatment for coronary artery disease is coronary intervention, especially in complicated instances with bifurcation lesions, recurrent complete occlusions, or multivessel disease. (13). In order to improve myocardial perfusion, interventional cardiology which includes minimally invasive procedures like coronary angiography and percutaneous coronary intervention assesses and treats constricted or blocked coronary arteries (14). The therapy comprises incorporating a guided catheter directed to the region of coronary artery obstruction, afterward inflating the balloon at the end to clear the blockage and placing a stent to preserve patency in persons with Coronary Artery Disease (15).

Coronary angiography is regarded as the “gold-standard” diagnostic technique in cardiology for identifying and assessing the severity of coronary artery stenosis or obstructions (16). Coronary Intervention is one of the most commonly employed means of enhancing blood flow to heart tissues during the course of Coronary Artery Disease treatment. PCI is highly efficient in terms of alleviating symptoms in patients suffering from stable angina and has a positive impact on the prognoses of patients suffering from Acute Coronary Syndrome (17).

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The frequency of vascular problems and patient outcomes can be greatly impacted by the choice of vascular access location, whether it be femoral or radial. In-hospital mortality was lower in the radial group (1.4%) than in the femoral group (4.3%, P=0.05) in a randomized controlled study of 350 complicated PCI patients (210 radial, 140 femoral), while periprocedural MI rates were comparable (0.5% vs. 0.7%). Both cohorts exhibited comparable and minimal incidences of hemorrhage and stent thrombosis (0.5% vs. 0.7% and 0.5% vs. 0%) (13). In patients receiving coronary intervention, bleeding at the vascular access site is a recognized complication (18).

Historically, the femoral artery has been the preferred access site due to its larger vascular diameter, which facilitates the use of larger catheters and devices (19). Nonetheless, it is linked to an increased occurrence of vascular problems, including hematomas, pseudoaneurysms, arteriovenous fistulas, and significant hemorrhage. Patients treated by femoral access experienced a greater incidence of access site problems at 22.9%, with severe bleeding occurring in 8.6% of instances (20). In addition, femoral access might be difficult in obese individuals or patients with peripheral artery disease, particularly the closure device deployment, leading to risk of hematoma and patient dissatisfaction (21).

Transradial technique for performing diagnostic angiography and angioplasty is becoming more common and is considered the preferred choice for coronary treatment procedures globally. The transradial approach has lower risks of vascular complications as well as bleeding than the transfemoral approach (22). Patients receiving primary PCI by radial approach had a markedly reduced incidence of access site problems at 11.4%, with severe bleeding occurring in about 2.3% of instances. The radial group also exhibited a reduced median hospital stay, facilitating early ambulation and endorsing a radial-first approach in difficult PCI (23).

However, radial access necessitates an extended learning curve to build technical expertise. There have been several studies recently conducted to show that there are significant differences among patients experiencing STEMI whether radial access is linked to lower

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mortality rates than femoral access. However, there is still no agreement about whether there are benefits of using radial access over femoral access during PCI procedures (21).

The majority of the data supporting radial access's advantage in terms of fewer vascular problems comes from high-income nations with standardized procedures, skilled operators, and well-equipped catheterization labs. Without locally generated information, it is impossible to infer that these findings apply to tertiary care facilities in Peshawar, Khyber Pakhtunkhwa, where patient demographics, comorbidity profiles, and procedural resources differ significantly (24). Therefore, the purpose of this study was to prospectively assess access-site challenges faced by patients receiving coronary procedures in Peshawar, between radial and femoral methods. In order to lower patient morbidity and enhance procedural outcomes in this area, the results of this study are meant to offer locally relevant evidence that can direct cardiologists, cardiology technologists, and hospital administrations in KPK toward implementing safer access-site practices.

Materials and Methods

This prospective comparative cohort study was conducted in the Department of Cardiology at Rehman Medical Institute, Peshawar, Pakistan, a tertiary care hospital equipped with a fully functional cardiac catheterization laboratory. The study was carried out over a period of six months and included adult patients undergoing coronary angiography and/or percutaneous coronary intervention (PCI) through either radial or femoral arterial access. Relevant clinical and procedural information was collected prospectively using a structured data collection form.

The sample size was calculated using the World Health Organization (WHO) sample size formula at a 95% confidence interval. In the absence of local prevalence data, a response distribution of 50% was assumed to obtain the maximum sample size, with a margin of error of 8.5%. The minimum required sample size was calculated to be 132 patients, who were allocated into radial and femoral access groups for comparison of access-site complications following coronary interventions (33). A convenience sampling technique was employed. Adult patients aged 19 years and above undergoing coronary intervention via radial or femoral

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access at Rehman Medical Institute were included in the study, while patients with incomplete or missing records were excluded.

` Data were collected prospectively throughout the study period. Following data collection, all records were reviewed for completeness and accuracy before analysis. Statistical analysis was performed using SPSS software. Descriptive statistics were used to summarize demographic characteristics, including age, sex, and comorbidities, as well as procedural variables such as the type of coronary intervention and vascular access site. The frequency and types of access-site complications, including hematoma, bleeding, pseudoaneurysm, and arterial occlusion, were calculated for each study group. Categorical variables were compared between the radial and femoral access groups using the Chi-square test, while continuous variables were compared using the independent samples *t*-test. The findings were presented in tables and graphs, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

This chapter presents the findings of the prospective comparative cohort study conducted in Peshawar, involving a total of 132 adult patients who underwent coronary interventions via either radial (n = 66) or femoral (n = 66) vascular access between February 1st and April 30th, 2026. The results are organised into two main sections. The first part covers the demographic comparability of the two groups, concentrating on age as a critical baseline variable, assessed using an independent samples t-test. The second section presents the frequency, distribution, and statistical association of access-site complications between the radial and femoral groups, assessed using cross-tabulation and the Pearson Chi-Square test. The SPSS program was used to analyze all of the data, and a p-value of less than 0.05 was considered statistically significant. To enable easy understanding and comparison between the two access groups, the results are displayed as tables and figures.

Table 1 displays the descriptive data for patient age (in years) within the two vascular access groups. The mean age of the femoral group (n = 66) was 52.21 ± 23.97 years, whereas that of the radial group (n = 66) was 57.93 ± 14.82 years. Greater variability in the age distribution of femoral access patients is suggested by the femoral group's much larger standard deviation

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(23.97 vs. 14.82), which shows a wider range of patient ages in that cohort. The inferential test presented in Table 3 provides standard error mean values of 1.82 (radial) and 2.95 (femoral) for comparison.

Table 1: Group Statistics — Mean Age Comparison Between Radial and Femoral Access Groups:

Group Statistics					
	Access Site	N	Mean	Std. Deviation	Std. Error Mean
Age in Years	Radial	66	57.9318	14.81940	1.82414
	Femoral	66	52.2139	23.97126	2.95066

Table 2 displays the outcomes of Levene's Test for Equality of Variances and the independent samples t-test assessing mean age differences between the radial and femoral groups. Given that Levene's test was statistically significant (F = 10.398, p = 0.002), indicating differential variances between the two groups, the "equal variances not assumed" row is the appropriate inferential conclusion. However, the t-test findings (t = 1.648, df = 108.352, p = 0.102) showed that there was no statistically significant difference between the two groups' ages. The lack of a significant age difference was further supported by the mean difference of 5.72 years (95% CI: −1.158 to 12.594), with the confidence interval crossing zero.

Table 2: Independent Samples Test — Comparison of Mean Age Between Access Groups

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

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Age in Years	Equal variances assumed	10.398	.002	1.648	130	.102	5.717	3.468	1.145	12.580
	Equal variances not assumed			1.648	108.352	.102	5.717	3.468	1.158	12.593

Table 3, presents both the frequency distribution and cross-tabulation of access-site complication types across the radial access group (n = 66) and the femoral access group (n = 66). For each complication category, the absolute count and the row percentage (percentage within each complication type) are reported.

Overall, 22 radial patients (33.3%) and 38 femoral patients (57.5%) experienced at least one access-site complication, confirming that femoral access patients had a higher overall complication burden. Hematoma was the dominant complication in the femoral group (n = 24, 36.4%), accounting for 92.3% of all hematoma cases across both groups, compared to only 2 radial patients (3.0%). Radial artery spasm occurred exclusively in the radial group (n = 14, 21.2%) and was entirely absent in femoral patients. Similarly, arterial occlusion was confined to the radial cohort (n = 5, 7.6%). Bleeding was equally distributed between groups (n = 5 per group, 50% each), as was infection at the access site (radial n = 4, 44.4%; femoral n = 5, 55.6%). The most serious complications — retroperitoneal hemorrhage (n = 2), arteriovenous fistula (n = 2), and pseudoaneurysm (n = 4) — occurred exclusively in the femoral group and were completely absent in the radial cohort. The total sample was equally divided, with 66 patients (50%) in each group.

Table 3. Frequency Distribution & Cross-tabulation of Complications by Access Site

Complications of radial and femoral Access Site Crosstabulation		
	Access Site	Total

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			Radial	Femoral	
Complications of radial and femoral	Complications	Count	22	38	60
		% within Complications of radial and femoral	33.3%	57.5%	100.0%
	Hematoma	Count	2	24	26
		% within Complications of radial and femoral	7.7%	92.3%	100.0%
	Bleeding	Count	5	5	10
		% within Complications of radial and femoral	50.0%	50.0%	100.0%
	Spasm	Count	14	0	14
		% within Complications of radial and femoral	100.0%	0.0%	100.0%
	AV Fistula	Count	0	2	2
		% within Complications of radial and femoral	0.0%	100.0%	100.0%
	Retroperitoneal Hemorrhage	Count	0	2	2
		% within Complications of radial and femoral	0.0%	100.0%	100.0%

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	Arterial Occlusion	Count	5	0	5
		% within Complications of radial and femoral	100.0%	0.0%	100.0%
	Pseudoaneurysm	Count	0	4	4
		% within Complications of radial and femoral	0.0%	100.0%	100.0%
	Infection at access site	Count	4	5	9
		% within Complications of radial and femoral	44.4%	55.6%	100.0%
Total		Count	66	66	132
		% within Complications of radial and femoral	50.0%	50.0%	100.0%

Table 4, reports the results of chi-square statistical tests assessing the significance of the association between vascular access site and type of complication. The Pearson Chi-Square value was 48.126 (df = 8, p < 0.001), and the Likelihood Ratio was 61.899 (df = 8, p < 0.001), both confirming a highly statistically significant association between access site and complication type.

Table 8: Chi-Square Tests for Association Between Access Site and Complications

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)

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Pearson Chi-Square	48.126[a]	8	.001
Likelihood Ratio	61.899	8	.001
Linear-by-Linear Association	.020	1	.888
N of Valid Cases	132		

A simple histogram *(Figure 1)* showing the frequency of reported pain levels at the access site across four categories: None, Mild, Moderate, and Severe. The majority of patients reported Mild pain (~72 cases), followed by None (~31), Moderate (~26), and Severe (~4). Although most patients had some discomfort, severe pain was uncommon, and mild pain was the most frequent outcome, according to this right-skewed distribution.

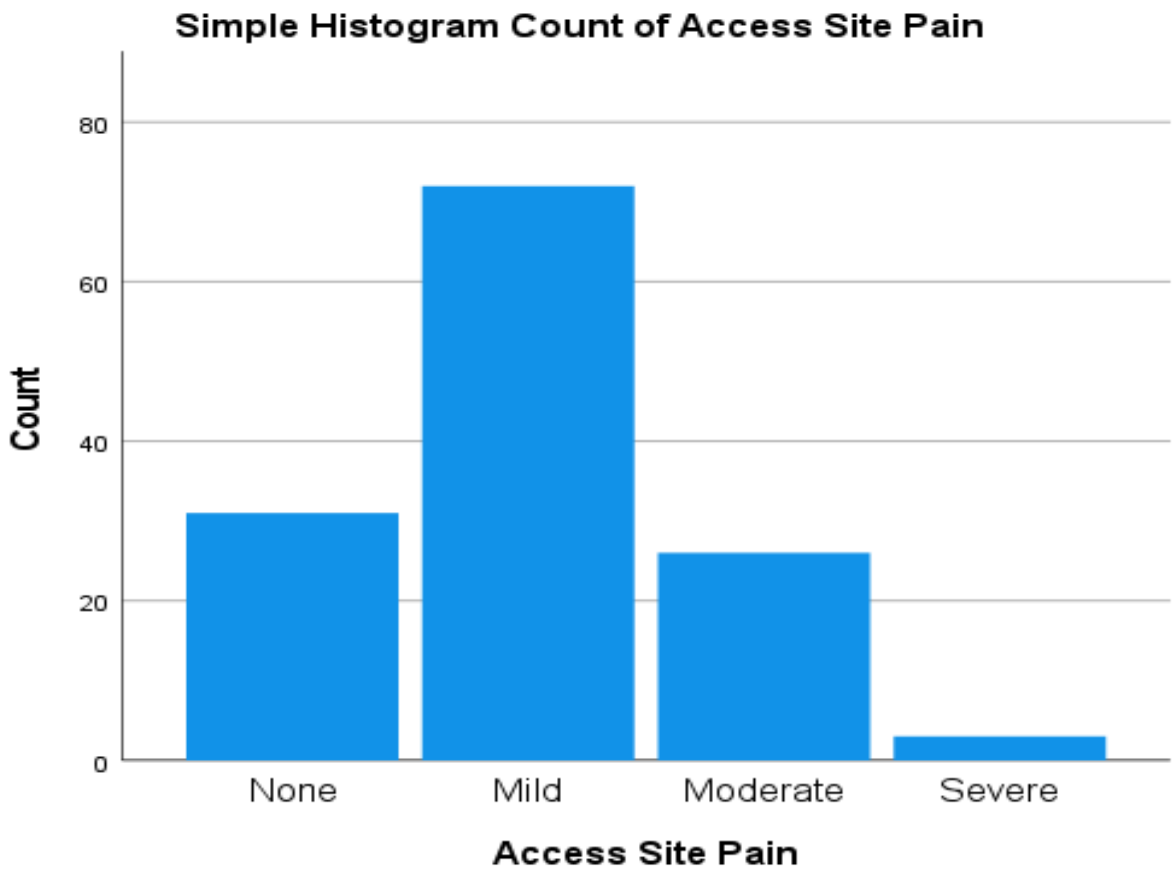

Figure 1: Distribution of Access Site Pain Levels

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A simple bar chart displaying the count of patients by their indication for Percutaneous Coronary Intervention (PCI). The most common indication (~63 cases) was Acute Coronary Syndrome (ACS), which was followed by Stable Angina (~43 cases) and other indications (~27 cases). This figure highlights that ACS is the predominant reason for PCI in this dataset, consistent with typical clinical patterns in interventional cardiology.

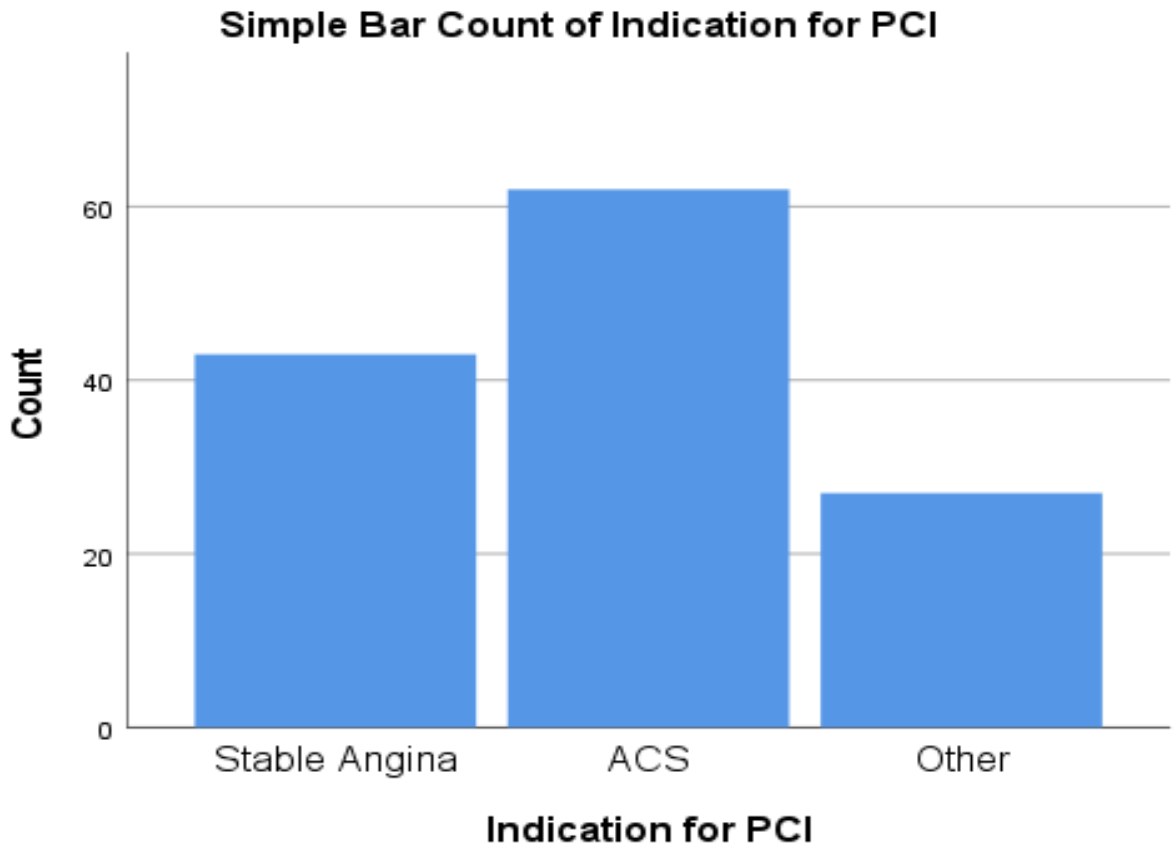

Figure 2: Distribution of PCI Indications

DISCUSSION

This prospective comparative cohort study evaluated access-site complication profiles among 132 patients undergoing PCI via radial or femoral approach (66 per group) at a tertiary cardiac

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centre in Peshawar. Baseline characteristics including age, gender, diabetes, hypertension, and prior CAD/PCI history were statistically comparable between groups, ensuring that observed differences in complications were attributable to access approach rather than confounding clinical variables. The principal finding revealed a highly significant association between access site and complication type ($\chi^2 = 48.126$, $p < 0.001$), with radial access demonstrating a superior safety profile. The majority of femoral patients (57.5%) experienced at least one access-site complication, compared to 33.3% in the radial group, confirming a superior safety profile for the trans radial approach.

Hematoma was the most frequent complication in the femoral group, occurring in 36.4% of femoral patients versus only 3.0% of radial patients consistent with findings reported by Ahmad et al. in complex PCI lesions. Furthermore, serious vascular complications including retroperitoneal haemorrhage, arteriovenous fistula, and pseudoaneurysm were exclusive to the femoral cohort, corroborating Ferrante's meta-analytic evidence on the potentially fatal risks of femoral access (20, 34). Importantly, according to Ferrante's meta-analytic evidence, retroperitoneal haemorrhage, arteriovenous fistula, and pseudoaneurysm were only seen in the femoral group and nonexistent in the radial cohort. This highlights the known risk of potentially fatal vascular complications linked to femoral access (35, 36).

Radial artery spasm (21.2%) and arterial occlusion (7.6%) were confined to the radial group, reflecting known technical limitations of the transradial approach. However, as noted by Caputo et al., these complications are generally manageable and rarely result in serious clinical consequences when appropriate antispasmodic prophylaxis and pre-procedural Allen's test screening are employed (37). Bleeding and infection rates were similar across both groups, reflecting equivalent procedural standards (38).

The limited sample size and short data collection window are acknowledged limitations, and the chi-square interpretation should be viewed with care given low anticipated cell counts in some uncommon complication categories.

This prospective study of 132 PCI patients at a tertiary cardiac center in Peshawar demonstrates that trans radial access is associated with significantly fewer and less severe

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access-site complications compared to transfemoral access (χ^2 = 48.126, p < 0.001). Serious vascular complications retroperitoneal hemorrhage, arteriovenous fistula, and pseudoaneurysm were exclusive to the femoral group, confirming rejection of the null hypothesis in favor of radial access superiority.

Given KPK's resource constraints, complex CAD burden, and limited post-procedural follow-up for rural patients, a radial-first strategy is strongly recommended for affiliated cardiac centers across the province. Transfemoral access should be reserved for anatomically or clinically justified cases only.

Structured training in trans radial technique encompassing spasm prevention, sheath sizing, and patent hemostasis should be prioritized in cardiology training programs across KPK to minimize learning-curve complications and maximize patient safety outcomes.

Future multi-center studies with larger sample sizes, longer follow-up, and adjustment for procedural complexity and operator volume will further strengthen the evidence base needed to guide regional and national policy in Pakistan.

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