



## Original Article

# Clinico-angiographic profile and procedural outcomes in patients undergoing percutaneous coronary interventions: The Srinagar registry



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## ARTICLE INFO

## Article history:

Received 7 October 2016

Accepted 31 January 2017

Available online 6 February 2017

## Keywords:

Coronary artery disease

Angiographic profile

Percutaneous coronary interventions

## ABSTRACT

**Background:** This study was aimed at exploring the clinical profile, angiographic characteristics and procedural outcomes in patients undergoing PCI at our institute.

**Methods:** This prospective observational study included all consecutive patients who underwent PCI at our hospital between January 2014 and December 2015. Data including clinico-demographic profile, angiographic details and lesion characteristics were recorded in all patients. Procedural details including devices and drugs used, procedure related complications, and in-hospital outcomes of these patients were analysed.

**Results:** A total of 624 patients (mean age-  $59.30 \pm 11.17$  years) with 84.8% males and 15.2% females were included in the study. Smoking and hypertension were the most common risk factors, present in 79.8% and 74.8% patients respectively. Diabetes mellitus, dyslipidemia, and obesity were observed in 24.5%, 26.1%, and 25.0% patients respectively. Anterior wall MI was the most common mode of presentation (32.1%). Single Vessel Disease (SVD) was most common angiographic pattern, observed in 50.3% patients; left anterior descending artery (LAD) was the most frequently involved vessel (65.9%); and type B lesions were most prevalent (52.3%). Most of the procedures were elective (61.4%) and femoral route was used in the majority (82.6%). Drug eluting stents were deployed in 99.1% of the cases. The overall procedural success rate was 93.6%. Procedural mortality was 1.0% and periprocedural complications occurred in 9.9% patients.

**Conclusion:** This first prospective PCI registry from the state of Jammu & Kashmir provides an insight into the patterns of CAD among Kashmiri population, and highlights the spectrum of PCIs performed with their outcomes.

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## 1. Introduction

Coronary artery disease (CAD) is leading cause of death worldwide and over three quarters of these deaths occur in low and middle income countries.<sup>1</sup> India is fast becoming the 'global capital' of coronary artery disease (CAD), contributing to 60% of

global burden of CAD, and the prevalence is rising even as we speak.<sup>2</sup> The genetic predisposition and rapid acquisition of cardiovascular risk factors secondary to urbanization seem to be the major contributors to this rising prevalence.<sup>3</sup> CAD tends to occur at a younger age in Indians with more extensive angiographic involvement.<sup>4</sup> CAD varies across geography, socio-demography, and ethnicity with marked interregional heterogeneity across the country.<sup>5</sup> In the state of Jammu and Kashmir, the population like any other developing community is undergoing lifestyle changes, but the unusual stress and strain due to the ongoing political turmoil over last three decades might also have modified the epidemiology of CAD in this population.

Paralleling this increased prevalence, the treatment of ischemic heart disease has also witnessed some revolutionary changes in last couple of decades. In particular, percutaneous coronary

*Abbreviations:* CAD, Coronary Artery Disease; MI, Myocardial Infarction; PCI, Percutaneous Coronary Intervention; CABG, Coronary Artery Bypass Grafting.

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<http://dx.doi.org/10.1016/j.ihj.2017.01.021>

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interventions (PCI) which include percutaneous transluminal coronary angioplasty (PTCA), stenting, and related techniques represent a major therapeutic advance in the management of CAD. PCI is effective in relieving symptoms and it improves survival in certain subsets of CAD patients.<sup>6,7</sup> Through advances in equipment and technical skills the profile of patients undergoing PCI is constantly evolving, with increasingly more complex patients and lesions being treated with this modality.<sup>8,9</sup>

There are presently over 500 centers with cardiac catheterization lab facilities across the country and these numbers are steadily growing.<sup>10</sup> Despite this increasing panorama, there is serious paucity of data regarding risk factors, angiographic profile and clinical outcomes in patients undergoing PCI in India, with so many caveats behind which formed the impetus to perform this study. This is the first study from Jammu and Kashmir conducted to explore the clinical profile of patients with CAD undergoing percutaneous revascularization in terms of risk factors, clinical presentation, and angiographic characteristics; and to analyse procedural outcomes at our hospital. Our endeavour was to generate baseline regional data and compare it to various national and international data available.

## 2. Patients and methods

Our study was a hospital based prospective observational study, conducted in the Department of Cardiology, Sher-i-Kashmir Institute of Medical Sciences (SKIMS), Srinagar, Jammu and Kashmir. This study included 624 consecutive patients who underwent Percutaneous Coronary Intervention (PCI) at cardiac catheterization lab of SKIMS between January 2014 and December 2015. All patients of coronary artery disease diagnosed on the basis of clinical history, 12 lead electrocardiogram (ECG) findings, biochemical markers, or non-invasive tests like treadmill test, echocardiography, stress radionuclide imaging and undergoing PCI were enrolled in this study after obtaining an informed consent. Patients were enrolled irrespective of their clinical presentation [stable angina, unstable angina, ST-elevation Myocardial Infarction (STEMI), and Non ST-elevation Myocardial Infarction (NSTEMI)]. Patients with previous history of allergy to radiographic contrast or severe renal insufficiency (eGFR <30 ml/min) were excluded. Demographic and clinical details of all patients were recorded. Conventional atherosclerotic risk factors (smoking, hypertension, diabetes mellitus, or dyslipidemia) were identified and documented in each patient. Smoking was defined as if the patient smoked >1 cigarette per day regularly for more than 6 months or had quit smoking for less than 2 years. Diabetes Mellitus was diagnosed on the basis of fasting plasma glucose of  $\geq 126$  mg/dL or Hemoglobin A<sub>1c</sub> greater than 6.5% or symptoms of diabetes plus random blood glucose concentration  $\geq 200$  mg/dL or patient on anti-diabetic medications.<sup>11</sup> Hypertension was considered to be present if the patient was taking any anti-hypertensive drugs at the time of presentation or if blood pressure recorded was  $\geq 140$  mmHg systolic and/or  $\geq 90$  mmHg diastolic, on at least two separate occasions.<sup>12</sup> Dyslipidemia was defined as total cholesterol  $\geq 200$  mg/dL, or LDL cholesterol  $\geq 130$  mg/dL, or triglycerides  $\geq 150$  mg/dL, or HDL cholesterol  $\leq 40$  mg/dL or any combination of these criteria.<sup>13</sup> The angiographic characteristics including site, severity, type and extent of lesions; and number of vessels involved were assessed. Stenosis in a vessel [other than left main coronary artery (LMCA)] was categorized as mild (<50% diameter stenosis), moderate (50–69% diameter stenosis) and severe ( $\geq 70\%$  diameter stenosis). LMCA lesions were classified as non-significant (<50% diameter stenosis) or significant ( $\geq 50\%$  diameter stenosis). CAD was categorized as single vessel disease

(SVD), double vessel disease (DVD), or triple vessel disease (TVD) according to number of major branches with significant involvement. Atherosclerotic lesions complexity was further categorized according to the Joint American College of Cardiology/American Heart Association (ACC/AHA) task force classification system.<sup>14</sup> The angiographic lesions with  $\geq 50\%$  stenosis in LMCA and  $\geq 70\%$  stenosis in other major vessels (reference vessel diameter  $\geq 2.25$  mm) were stented. Severe stenosis in smaller vessels (reference vessel diameter <2.25 mm) were either left alone or subjected to plain old balloon angioplasty (POBA) depending upon operators judgement. Procedural details including vascular access route, site and number of lesions intervened upon, size and number of stents used, periprocedural pharmacotherapy, and use of adjunctive devices were recorded. Procedural success rates and in-hospital outcomes, with the intent to highlight complications associated with the procedures were also assessed.

### 2.1. Operational definitions

- i. *Stable angina*: It was diagnosed on the basis of clinical (chest pain- typical or atypical) and non-invasive evaluation ( $\geq 1$  mm horizontal or down sloping ST-depression on exercise ECG or perfusion defects on technetium 99 sestamibi scan).
- ii. *Myocardial infarction (MI)*: It was diagnosed in the presence of two of the following criteria: pain suggestive of myocardial ischemia lasting for at least 30 min; unequivocal new electrocardiographic alterations; or positive results of qualitative troponin T or I assay (ROCHE diagnostic kits, Germany). Patients with both STEMI and NSTEMI were included. STEMI was diagnosed when ST elevation of  $\geq 2$  mm in two or more contiguous precordial leads, or  $\geq 1$  mm in at least two contiguous limb leads or when new or presumably new left bundle branch block was observed on ECG.
- iii. *Unstable Angina*: It was diagnosed in presence of typical ischemic chest discomfort of increasing severity and ST segment depression of 1 mm on limb leads or 2 mm on chest leads with negative results of qualitative troponin T or I assay.
- iv. *Type A Lesions*: It included lesions having any of the following characteristics; discrete (<10 mm length), concentric, readily accessible, non-angulated segment (<45°), smooth contour, little or no calcification, less than totally occlusive, non-ostial location, no major side branch involvement, and absence of thrombus.
- v. *Type B Lesions (moderate risk)*: It included lesions having any of the following characteristics; tubular (10 to 20 mm length), eccentric, moderate tortuosity of proximal segment, moderately angulated segment ( $\geq 45^\circ$  but <90°), irregular contour, moderate to heavy calcification, total occlusions <3 months old, ostial in location, bifurcation lesion requiring double guidewires, and some thrombus present.
- vi. *Type C Lesions*: It included lesions having any of the following characteristics; diffuse (>20 mm length), excessive tortuosity of proximal segment, extremely angulated segments  $\geq 90^\circ$ , total occlusion >3 months old, inability to protect major side branches, and degenerated vein grafts with friable lesions.
- vii. *Coronary artery territories and segments*: The left main coronary artery was considered a segment and a territory of its own. Proximal segments comprised the proximal parts of the left anterior descending (LAD), the left circumflex (LCX), and the right coronary arteries (RCA). Mid segments consisted of the mid parts of the 3 main coronary arteries, and of the proximal 1 to 2 cm of major diagonal and obtuse marginal branches. Segments distal to mid segments were considered distal.

- viii. *Ostial stenosis*: A stenosis was classified as “ostial” when the origin of the lesion was within 3 mm of the vessel origin involved.
- ix. *Thrombus*: It was defined as a discrete, intraluminal filling defect with defined borders and largely separated from the adjacent vessel wall. Contrast staining might or might not be present.
- x. *Tortuosity*: Stenosis distal to two bends  $>75^\circ$  was considered moderately tortuous, and those distal to three or more bends  $>75^\circ$  were considered excessively tortuous.
- xi. *Bifurcation stenosis*: Stenosis involving the parent and daughter branch if a medium or large branch ( $>1.5$  mm) originated within the stenosis and if the side branch was completely surrounded by stenotic portions of the lesion to be dilated.
- xii. *Calcification*: Calcification was recorded if readily apparent densities were seen within the apparent vascular wall of the artery at the site of the stenosis.
- xiii. *Chronic total occlusion*: A total occlusion [thrombolysis in myocardial infarction (TIMI) flow grade 0], judged to be  $\geq 3$  months duration on the basis of clinical and angiographic findings, was considered as a chronic total occlusion (CTO).
- xiv. *Eccentric stenosis*: A stenosis was classified as eccentric when one of its luminal edges was in the outer one quarter of the apparent normal lumen.
- xv. *Irregular contour*: A stenosis was classified as having irregular contour if the vascular margin was rough or had a “saw tooth” appearance.
- xvi. *Procedural success*: The procedure was considered successful if the visual angiographic estimate of residual coronary stenosis was  $<10\%$  in stented segments or  $<50\%$  in balloon angioplasty segments, with the presence of TIMI III flow in the target vessel; without side branch loss, flow-limiting dissection, or angiographic thrombus; and without associated in-hospital major clinical complications (e.g. death, MI, stroke, or emergency CABG).<sup>15</sup>
- xvii. *Procedural complications*: These included death, procedure related MI, emergency CABG, periprocedural stroke, vascular complications (access site hematoma, retroperitoneal haemorrhage, pseudoaneurysm, arteriovenous fistula, arterial dissection and/or occlusion), periprocedural bleeding, coronary perforation, acute stent thrombosis, flow limiting coronary dissection, side branch loss, arrhythmias requiring specific interventions, and contrast induced acute kidney injury (AKI). All these complications were defined according to the contemporary guidelines.<sup>15</sup>

## 2.2. Statistical methods

Statistical analysis was performed by SPSS software package (version 20.0, SPSS Inc, Chicago, Illinois, USA). All continuous variables were expressed as mean  $\pm$  standard deviation (SD), and categorical variables were reported as frequency and percentages. For univariate analysis of categorical variables, Chi-square test or Fisher’s exact test, whichever appropriate, was employed. Continuous variables were analysed with the help of Student’s *t*-test. A *p* value  $<0.05$  was considered statistically significant.

## 3. Results

Over a period of two years, a total of 624 patients who fulfilled the eligibility criteria were included in this study.

### 3.1. Patient characteristics and clinical presentation

The demographic and clinical profile of the study patients is described in Table 1. The mean age of the study group was  $59.30 \pm 11.17$  years. Among the 624 patients studied, 529 were males (84.8%) and 95 females (15.2%), with the male to female ratio of 5.6:1 (Table 1). The mean age at presentation was more than a decade later in females as compared to males ( $67.42 \pm 12.34$  vs

**Table 1**  
Demographic and Clinical Profile of the Study Population.

Variable	Subgroup	Males		Females		Total		P value
		N (529)	%	N (95)	%	N (624)	%	
Age (years)	<40	33	6.2	0	0	33	5.3	<0.0001
	41–70	455	86.0	64	67.4	519	83.2	
	>70	41	7.8	31	32.6	72	11.5	
Smoking	Present	495	93.6	3	3.2	498	79.8	<0.0001
	Absent	34	6.4	92	96.8	126	20.2	
Hypertension	Present	394	74.5	73	76.8	467	74.8	0.625
	Absent	135	25.5	22	23.2	157	25.2	
Diabetes mellitus	Present	121	22.9	32	33.7	153	24.5	0.024
	Absent	408	77.1	63	66.3	471	75.5	
Dyslipidemia	Present	127	24.0	36	37.9	163	26.1	0.005
	Absent	402	76.0	59	62.1	461	73.9	
Obesity	Present	107	20.2	49	51.6	156	25.0	<0.0001
	Absent	422	79.8	46	48.4	468	75.0	
Family History	Present	23	4.3	5	5.3	28	4.5	0.692
	Absent	506	95.7	90	94.7	596	95.5	
Clinical Presentation	AWMI	178	33.6	22	23.2	200	32.1	0.003
	IWMI	147	27.8	19	20.0	166	26.6	
	UA/NSTEMI	73	13.8	25	26.3	98	15.7	
	CSA	131	24.8	29	30.5	160	25.6	
Angiographic Profile	SVD	273	51.6	41	43.1	314	50.3	0.011
	DVD	169	31.9	26	27.4	195	31.3	
	TVD	87	16.5	28	29.5	115	18.4	

Note: AWMI, Anterior Wall Myocardial Infarction; IWMI, Inferior Wall Myocardial Infarction; UA, Unstable Angina; NSTEMI, Non ST elevation Myocardial Infarction; CSA, Chronic Stable Angina; SVD, Single Vessel Disease; DVD, Double Vessel Disease; TVD, Triple Vessel Disease; N, Number; %, Percentage.

55.26 ± 8.68 years,  $p < 0.0001$ ). Among the risk factors studied, smoking and hypertension were the most common, present in 79.8% and 74.8% patients respectively. Diabetes mellitus, dyslipidemia, obesity and family history of CAD were present in 24.5%, 26.1%, 25.0% and 4.5% patients respectively. Smoking was significantly more frequent in males (93.6% in males vs 3.2% in females,  $p < 0.0001$ ); while diabetes mellitus (22.9% in males vs 33.7% in females,  $p = 0.024$ ), dyslipidemia (24.0% in males vs 37.9% in females,  $p = 0.005$ ), and obesity (20.2% in males vs 51.6% in females,  $p < 0.0001$ ) were more prevalent in females. Overall, anterior wall MI was the most common mode of presentation (32.1%) followed by inferior wall MI (26.6%) and stable angina (25.6%). In males, anterior wall MI was the most common mode of presentation (33.6%); while in females, stable angina was the most common mode (30.5%). Non ST elevation Acute Coronary Syndromes (unstable angina and NSTEMI) were more common in females (26.3%) as compared to males (13.8%).

### 3.2. Coronary angiographic profile

Single Vessel Disease (SVD) was most common angiographic pattern, observed in 314 patients (50.3%), followed by Double Vessel Disease (DVD) in 195 patients (31.3%), and Triple Vessel Disease (TVD) in 115 patients (18.4%). Most common vessel involved was the LAD, seen in 65.9% patients, followed by RCA in 55.0% and LCX in 36.2%. LMCA disease was seen in 26 patients (4.2%), all of whom had multivessel CAD (Table 2). Most common site of obstruction was the proximal segment, in 449 (35.8%), followed by mid-segment in 413 (32.9%), distal segment in 258 (20.5%), and ostial location in 115 (9.2%) of all lesions (Table 3).

A total of 1256 lesions were analysed on angiography of which 823 (65.5%) were severe, 229 (18.2%) were moderate, and 204 (16.3%) were mild (Table 3). When these lesions were categorized according to the ACC/AHA lesion classification system, 317 (25.2%) were Type A lesions, 657 (52.3%) were Type B lesions, and 282 (22.5%) were Type C lesions. The lesion characteristics are described in Table 4. Notably, calcified lesions were distinctly infrequent, constituting 3.3% of all lesions; while eccentric, irregular and thrombus containing lesions were common, accounting for 52.0%, 29.9% and 15.4% of all lesions respectively. Bifurcation lesions and CTOs accounted for 20.8% and 5.5% of all lesions respectively. Among 15 patients who had previously undergone CABG, 21 bypass graft lesions were identified.

### 3.3. Coronary interventions

A total of 801 PCIs were performed in 624 patients. These included 492 (61.4%) elective PCIs, 143 (17.9%) pharmacoinvasive PCIs, 96 (12.0%) primary PCIs, 41 (5.1%) rescue PCIs, and 29 (3.6%) early invasive PCIs (in patients with NSTEMI). Majority of the procedures were performed via femoral approach 662 (82.6%),

while radial access was utilized in 139 (17.4%) patients. A total of 769 stents were deployed, including 751 drug eluting stents (DES), 11 bioabsorbable vascular scaffolds (BVS) and 7 bare metal stents (BMS). Plain old balloon angioplasty (POBA) without stenting was performed on 13 lesions, all of which were distally located with small reference vessel diameter ( $< 2.25$  mm). The mean number of stents per patient was  $1.24 \pm 0.52$ . LAD was the most common vessel stented with 331 stents used in 296 patients. LMCA was stented in 15 patients. Bypass graft intervention was performed in 4 patients. The mean stent size used at various locations of the major coronary arteries is shown in Table 5. Post dilatation with non-compliant balloons was performed in 685 out of 769 stents (89.1%).

Periprocedural anticoagulation included unfractionated heparin in 575 (92.1%), and enoxaparin in 49 (7.9%) of the cases. The most common antiplatelet regimen used was the combination of aspirin and clopidogrel in 542 (86.8%) patients. Prasugrel and Ticagrelor were used in 51 (8.2%) and 31 (5.0%) patients respectively. High dose statins (atorvastatin 40/80 mg or rosuvastatin 40 mg) were routinely given to all the patients before and after the procedure. Glycoprotein IIb/IIIa inhibitors were used in 153 (24.5%) patients. Thrombus aspiration devices were used in 47 (7.5%) patients. Other adjuvant devices included intravascular ultrasound (IVUS) in 21 (3.4%), rotational atherectomy in 8 (1.3%), cutting balloons in 3 (0.5%), and fractional flow reserve (FFR) assessment in 27 (4.3%) cases.

### 3.4. Procedural outcomes

The overall procedural success rate was 93.6%. Major reasons for failed procedure included failure to cross a CTO with guidewire (1.7%), inability to track balloon or stent across the lesion (0.6%), suboptimal post-procedural flow in the target vessel (0.9%), side branch loss (0.3%), flow limiting dissection (0.1%), periprocedural MI (1.5%), acute stent thrombosis (0.1%), periprocedural stroke (0.3%) and death (0.8%). Procedure related complications occurred in 62 (9.9%) patients (Table 6). Most common among these were contrast induced AKI (2.1%), periprocedural MI (1.9%), and vascular complications (1.3%). Procedure related mortality was 1.0% and occurred exclusively in STEMI patients. Among 6 patients who died, 2 had no reflow phenomenon that was refractory to drugs, 2 died of cardiogenic shock, 1 developed intracerebral bleed, and 1 had acute stent thrombosis.

## 4. Discussion

The main findings of this study were:

- The patient population undergoing PCI at our institute was relatively young (mean age-  $59.30 \pm 11.17$  years) with females presenting a decade later than males.
- Smoking was the most common risk factor observed (79.8%) and STEMI was the most frequent mode of presentation (58.7%).
- SVD was the most common angiographic pattern (50.3%), LAD was the most frequently involved vessel (65.9%), and majority of the lesions were type B (52.3%).
- Majority of our procedures (61.4%) were performed on elective basis, and femoral access was utilized in 82.6% patients.
- The overall procedural success rate was 93.6%. Procedure related mortality was 1% and complications occurred in 9.9% patients.

We are living in an era that is witnessing an exponential growth of PCI as a treatment modality of obstructive CAD. As far as the state of Jammu and Kashmir is concerned, there are currently five centers with cardiac catheterization lab facilities, catering to a

**Table 2**  
Angiographic profile of the patients.

Vessel Involved	SVD		DVD		TVD		Total	
	N (314)	%	N (195)	%	N (115)	%	N (624)	%
LMCA	0	0.0	7	3.6	19	16.5	26	4.2
LAD	161	51.3	137	70.3	113	98.3	411	65.9
LCX	39	12.4	81	41.5	106	92.2	226	36.2
RCA	113	36.0	121	62.1	109	94.8	343	55.0
RAMUS	1	0.3	4	2.1	17	14.8	22	3.5

Note: SVD, Single Vessel Disease; DVD, Double Vessel Disease; TVD, Triple Vessel Disease; LMCA, Left Main Coronary Artery; LAD, Left Anterior Descending Artery; LCX, Left Circumflex Artery; RCA, Right Coronary Artery; N, Number; %, Percentage.

**Table 3**  
Lesion distribution in various territories involved.

Vessel	Stenosis (%)	Site of Stenosis						Total			
		Ostial		Shaft		Distal		N	%		
		N	%	N	%	N	%				
LMCA	< 50	4	36.4	2	18.2	5	45.4	11	100.0		
	≥ 50	6	40.0	2	13.3	7	46.7	15	100.0		
	Total	10	38.5	4	15.4	12	46.1	26	100.0		
Ramus		Ostial-Proximal		Mid-Distal		Total					
	< 50	N	%	N	%	N	%	N	%		
	50-69	5	35.7	9	64.3	14	100.0	14	100.0		
	≥ 70	2	25.0	6	75.0	8	100.0	8	100.0		
	Total	3	30.0	7	70.0	10	100.0	10	100.0		
		10	31.2	22	68.8	32	100.0	32	100.0		
LAD		Ostial		Proximal		Middle		Distal		Total	
	< 50	N	%	N	%	N	%	N	%	N	%
	50-69	12	16.9	18	25.4	24	33.8	17	23.9	71	100.0
	≥ 70	10	15.9	15	23.8	22	34.9	16	25.4	63	100.0
	Total	21	6.0	168	48.3	136	39.1	23	6.6	348	100.0
		43	8.9	201	41.7	182	37.8	56	11.6	482	100.0
RCA	< 50	7	13.7	15	29.4	19	37.3	10	19.6	51	100.0
	50-69	9	15.3	20	33.9	14	23.7	16	27.1	59	100.0
	≥ 70	10	3.7	105	39.0	83	30.9	71	26.4	269	100.0
	Total	26	6.9	140	36.9	116	30.6	97	25.6	379	100.0
LCX	< 50	11	22.9	12	25.0	15	31.3	10	20.8	48	100.0
	50-69	13	13.7	29	30.5	31	32.6	22	23.2	95	100.0
	≥ 70	8	4.6	61	35.3	65	37.6	39	22.5	173	100.0
	Total	32	10.1	102	32.3	111	35.1	71	22.5	316	100.0
Bypass Grafts		SVG		LIMA		Total					
	< 50	N	%	N	%	N	%	N	%		
	50-69	7	77.8	2	22.2	9	100.0	9	100.0		
	≥ 70	3	75.0	1	25.0	4	100.0	4	100.0		
	Total	5	62.5	3	37.5	8	100.0	8	100.0		
		15	71.4	6	28.6	21	100.0	21	100.0		

Note: LMCA, Left Main Coronary Artery; LAD, Left Anterior Descending Artery; LCX, Left Circumflex Artery; RCA, Right Coronary Artery; SVG, Saphenous Vein Grafts; LIMA, Left Internal Mammmary Artery; N, Number; %, Percentage.

**Table 4**  
Lesion classification and characteristics.

Angiographic Findings		LMCA	LAD	RCA	LCX	Ramus	Total
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
ACC/AHA Lesion Type	Type A	4 (15.4)	138 (28.6)	103 (27.2)	61 (19.3)	11 (34.4)	317 (25.2)
	Type B	21 (80.8)	240 (49.8)	205 (54.1)	173 (54.7)	16 (50.0)	657 (52.3)
	Type C	1 (3.8)	104 (21.6)	71 (18.7)	82 (26.0)	5 (15.6)	282 (22.5)
Lesion Characteristics	Ostial Stenosis	10 (38.5)	43 (8.9)	26 (6.9)	32 (10.1)	4 (12.5)	115 (9.2)
	Bifurcation Stenosis	16 (61.5)	118 (24.5)	56 (14.8)	69 (21.8)	2 (6.3)	261 (20.8)
	Calcification	7 (26.9)	15 (3.1)	10 (2.6)	9 (2.9)	1 (3.1)	42 (3.3)
	Chronic Total Occlusion	0 (0.0)	35 (7.3)	20 (5.3)	14 (4.4)	0 (0.0)	69 (5.5)
	Moderate-Excessive Tortuosity	0 (0.0)	47 (9.8)	54 (14.3)	43 (13.6)	0 (0.0)	144 (11.5)
	Thrombus	2 (7.7)	76 (15.8)	92 (24.3)	23 (7.3)	0 (0.0)	193 (15.4)
	Eccentricity	12 (46.2)	261 (54.1)	193 (50.9)	172 (54.4)	15 (46.9)	653 (52.0)
	Irregular Contour	5 (19.2)	137 (28.4)	161 (42.5)	65 (20.6)	7 (21.9)	375 (29.9)
	Diffuse/Small vessel disease	0 (0.0)	23 (4.8)	17 (4.5)	31 (9.8)	1 (3.1)	72 (5.7)
	Bypass graft lesions	-	-	-	-	-	21 (1.7)

Note: ACC, American College of Cardiology; AHA, American Heart Association; LMCA, Left Main Coronary Artery; LAD, Left Anterior Descending Artery; LCX, Left Circumflex Artery; RCA, Right Coronary Artery; N, Number; %, Percentage.

**Table 5**  
Stent deployment locations and stent size used.

LMCA	Ostial (n=6)	Shaft (n=2)	Distal (n=7)	Total (n=15)	
	4.00 × 13.23	3.96 × 14.68	3.88 × 20.36	3.94 × 16.75	
Ramus	Ostial-Proximal (n=3)		Mid-Distal (n=7)	Total (n=10)	
	3.32 × 18.77		2.61 × 24.03	2.82 × 22.45	
LAD	Ostial (n=18)	Proximal (n=165)	Mid (n=132)	Distal (n=16)	Total (n=331)
	3.87 × 19.69	3.76 × 26.41	3.37 × 25.72	2.72 × 24.67	3.56 × 25.69
RCA	Ostial (n=8)	Proximal (n=102)	Mid (n=80)	Distal (n=63)	Total (n=253)
	3.71 × 18.96	3.58 × 28.07	3.29 × 26.64	2.76 × 27.81	3.29 × 27.26
LCX	Ostial (n=6)	Proximal (n=58)	Mid (n=61)	Distal (n=31)	Total (n=156)
	3.45 × 16.23	3.14 × 21.68	2.82 × 25.31	2.54 × 22.34	2.91 × 23.02
Bypass Grafts	SVG (n=3)		LIMA (n=1)	Total (n=4)	
	3.83 × 23.00		3.00 × 24.00	3.62 × 23.25	

Note: LMCA, Left Main Coronary Artery; LAD, Left Anterior Descending Artery; LCX, Left Circumflex Artery; RCA, Right Coronary Artery; SVG, Saphenous Vein Grafts; LIMA, Left Internal Mammmary Artery N, Number; %, Percentage.

population of about 14 million. Our institute was the first to acquire a catheterization lab in the year 2004 and we have been performing coronary interventions for over a decade now. With more than 400 PCIs performed annually, our center contributes roughly three fourths of all PCIs performed in the state. The present study provides an insight into the profile of patients undergoing PCI at our institute, and critically analyses the procedural indications, technical intricacies and clinical outcomes in these patients.

The mean age of our study population was  $59.30 \pm 11.17$  years. This is consistent with previous studies, suggesting that CAD presents a decade or so earlier in Indian population when compared to patients from western countries, leading to the loss of productive years of life fighting this disease.<sup>3–5,16,17</sup> The mean age at presentation was more than a decade later in females as compared to males ( $67.42 \pm 12.34$  vs  $55.26 \pm 8.68$  years), confirming the delayed presentation of CAD in females.<sup>18</sup> The male to female ratio in this study was 5.6:1. This strong male preponderance has been demonstrated in various Indian studies conducted previously.<sup>19,20</sup>

Smoking was the most common cardiovascular (CV) risk factor observed in our population (79.8%), and was more frequent in males (93.6% in males vs 3.2% in females,  $p < 0.0001$ ). This frequency is nearly double of what has been reported in other studies from India (33% to 48%).<sup>16,21,22</sup> This strikingly high prevalence of smoking could in part be attributed to the unusual

stress and strain of the prevailing political turmoil in the Kashmir valley, which has led the younger generation to take up this unhealthy habit. Hypertension was the second most common risk factor seen in 74.8% of the patients studied. It was the most common risk factor in females (76.8%). Diabetes mellitus, dyslipidemia, and obesity were significantly more prevalent among females as compared to males. A recent study conducted by Bhatt et al. also reported similar findings.<sup>19</sup> As is true with the rest of our country, majority of the females in Kashmir have a home bound life style and unhealthy eating habits, giving rise to higher prevalence of these metabolic risk factors. Family history of CAD was present in only 4.5% of our patients which is distinctly less than that observed in other studies (18% to 19%).<sup>23,24</sup> Whether this reflects a stronger role of acquired CV risk factors in the genesis of CAD in our population needs to be ascertained in larger epidemiological studies.

Overall STEMI was the most frequent mode of presentation (58.7%), but stable angina was the most common clinical presentation in females (30.5%). The frequency of non ST elevation acute coronary syndromes in females was nearly double than that of males. These figures are concordant with previous Indian studies, reiterating the fact that majority of the PCIs in our country are performed in the setting of acute coronary syndromes (ACS).<sup>25,26</sup> These data are in sharp contrast to those reported from western countries, where chronic stable angina is the initial manifestation of CAD in approximately one half of the patients and constitutes up to two-thirds of the patients that undergo percutaneous coronary revascularization.<sup>27,28</sup> These contrasting findings could be explained either due to underdiagnosis of stable CAD in our health care setup or due to more malignant presentation of CAD in our population.

Majority of our procedures (61.4%) were performed on elective basis. Although more than half of the patients had presented to us with STEMI, only 12% of all procedures were primary PCIs. It is a well-established fact that primary PCI is unequivocally superior to thrombolysis, both in terms of achieving rapid and sustained patency of the infarct related artery as well as minimizing bleeding complications in STEMI patients.<sup>29,30</sup> Our data is in sync with data from recent multicentre registries which showed that less than 15% of STEMI patients in India are reperfused with primary PCI.<sup>16,25</sup> The underutilization of this modality and overreliance on fibrinolysis for STEMI reperfusion in our country deserves special attention. The major hurdles in implementation of primary PCI as a routine strategy in countries like India include limited availability of regional centers of excellence, financial constraints, logistic and infrastructural difficulties, poor emergency medical services, and lack of public awareness. Thus there is a vast scope of improvement

**Table 6**  
Procedural outcomes and complications.

Complications	N = 62	%
Death	6	1.0
Periprocedural MI	12	1.9
Stroke	2	0.3
Emergency CABG	1	0.2
Slow flow/No Reflow	7	1.1
Flow limiting dissection	1	0.2
Major side branch loss	2	0.3
Coronary Perforation	2	0.3
Stent embolization	1	0.2
Air embolism	1	0.2
Acute stent Thrombosis	1	0.2
Vascular complications	8	1.3
Major bleeding	3	0.5
Arrhythmias	2	0.3
Contrast induced AKI	13	2.1

Note: AKI, Acute Kidney Injury; CABG, Coronary Artery Bypass Grafting; MI, Myocardial Infarction; N, Number; %, Percentage.

as far as STEMI management in our country is concerned, with urgent measures needed to overcome these challenges. One approach that has recently gained popularity is to administer fibrinolysis at the peripheral health centers and then rapidly transfer the patients to PCI capable hospitals for routine coronary angiography and PCI within 3 to 24 h of thrombolysis (pharmacoinvasive approach). This approach, which constituted 17.9% PCIs at our center, combines the benefits of establishing flow in the infarct related artery (IRA) by early fibrinolysis and maintaining sustained patency of IRA by routine early PCI, and has been demonstrated to provide results equivalent to primary PCI.<sup>31</sup> In fact this approach has been strongly promoted at our institute for managing STEMI patients who, due to aforementioned reasons, cannot undergo primary PCI on timely basis. Our endeavour has been to perform coronary angiography/PCI in thrombolysed patients as soon as logistically possible, after first 3 h, so that they can derive maximum benefit from mechanical revascularization.

As regards to the angiographic profile of the patients, SVD was the most common angiographic pattern (50.3%); LAD was the most common vessel involved (65.9%); and majority of the lesions were proximally located (35.8%). These data are comparable to those observed in previous studies.<sup>21,22,25,32</sup> LMCA disease was seen in 4.2% patients, all of whom had multivessel CAD. In terms of lesion characteristics, majority of the lesions were severe (65.5%); and type B lesions were most frequent (52.3%). Notably, calcified lesions were distinctly infrequent, constituting only 3.3% of all lesions. Some plausible reasons that could explain this finding include the following. First, our study cohort was relatively young and calcific disease, which is known to be more frequent in older populations, was therefore an infrequent observation.<sup>33</sup> Second, we relied only on cine fluoroscopy to identify coronary calcification. The incidence could have been higher if more sensitive techniques like IVUS were used to identify coronary calcification.<sup>34</sup> Third, the lower prevalence of calcified CAD could be related to ethnic attributes of the Kashmiri population. Eccentric, irregular and thrombus containing lesions (52.0%, 29.9% and 15.4% respectively) were frequently observed because majority of our patients presented with ACS. Ostial lesions, bifurcation stenosis, tortuous lesions and CTOs accounted for 9.2%, 20.8%, 11.5% and 5.5% of all lesions. These proportions are comparable to national and regional data.<sup>25,35</sup>

Majority of the procedures were performed via femoral approach (82.6%), while radial access was utilized in 17.4% patients. In USA, about 16% of all PCIs are performed via radial route while as in Europe, 80% operators use radial approach for PCI.<sup>36,37</sup> Recent data from India suggest that radial PCI constitutes 32.5% of all PCIs performed.<sup>25</sup> It is now an established fact that access site complications, bleeding and mortality rates are significantly reduced by using radial access.<sup>38</sup> Although transradial approach requires a definite learning curve, it is associated with higher procedural success rates and lower radiation exposure among experienced operators. Therefore its use needs to be strongly encouraged in both patients' as well as operators' interest. Periprocedural anticoagulation included unfractionated heparin in 92.1%, and enoxaparin in 7.9% of the cases. Bivalirudin was not used at all in our center. Data from the National Interventional Council (NIC) shows that bivalirudin is used in less than 1.5% of all coronary interventions in India.<sup>25</sup> Bivalirudin use has declined globally after the controversial results of recent randomized trials, which showed that there was no significant reduction in bleeding complications with its use when compared to unfractionated heparin.<sup>39</sup> The most common antiplatelet regimen used in our patients was the combination of aspirin and clopidogrel (86.8%). Prasugrel and Ticagrelor were used in 8.2% and 5% patients respectively. Major apprehensions with their use were higher cost

and the fear of bleeding complications. Glycoprotein IIb/IIIa inhibitors were used in 24.5% patients, with their use primarily restricted to STEMI patients with significant angiographic thrombus burden (TIMI grade  $\geq$  II); and as a bailout for procedural complications (coronary dissections, side branch compromise, residual thrombus, or slow flow phenomenon). Thrombus aspiration devices were used in 7.5% procedures, most of them being primary or rescue PCIs. These were utilized for both aspiration thrombectomy [where thrombus burden was high (TIMI grade  $\geq$  III)] as well as delivery of drugs to improve microvascular perfusion distal to the culprit lesion in cases with slow flow. Other adjunct devices like IVUS, rotablation, cutting balloons, and FFR assessment were utilized in less than 10% of the procedures. The low prevalence of calcific CAD was the main reason for limited use of cutting balloons and rotablation, while high procedural cost was the major hindrance for utilization of IVUS and FFR. Drug eluting stents (DES) comprised 99.1% of all stents deployed, while bare metal stents (BMS) were used in <1% of the cases. The proportional DES use is much higher than reported by the NIC across the country (81.1%) and was mainly because of our prioritization of resources and cheaper subsidized prices of DES at our hospital pharmacy.<sup>25</sup>

The overall procedural success rate at our institute was 93.6%. Most common cause of failed PCI was inability to cross a CTO with a guidewire (1.7%). Procedure related mortality was 1.0% and was exclusive to very sick subset of STEMI patients. Procedure related complications occurred in 9.9% patients, with most of them being non-lethal and managed successfully before hospital discharge. These figures match well with national and global standards.<sup>40</sup>

## 5. Limitations

The present study had some important limitations. First, this was a single center study with a relatively small sample size and thus may be fraught with referral bias. Second, we only included patients undergoing PCI in this study with many patients, who could not undergo coronary angiography or PCI for a variety of reasons, being excluded. Thus some of our findings may not be accurately reflective of the spectrum of CAD in the population at large. Thirdly, because of the limited sample size the procedural outcomes were reported in general and distinction of results between simple vs complex or emergent vs elective procedures was not made. Lastly, no data on follow up as well as the coronary imaging (e.g. IVUS) findings of patients, in whom it was performed, were collected in this study. Hence further short term and long term follow up data needs to be collected in this patient cohort to provide further insight into their clinical outcomes.

## 6. Conclusion

This is the first prospective PCI registry from the state of Jammu & Kashmir that provides an insight into the patterns of CAD among Kashmiri population, and highlights the spectrum of PCIs performed with their outcomes. We strongly believe that there is a need to establish such registries in all states of India that would enable us to enrich our databases and work towards improving quality of care by providing data feedback on wide range of performance metrics.

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