

Evaluation of Primary Percutaneous Coronary Intervention Outcomes in Elderly Patients with Acute Myocardial Infarction: An Observational Study

Girish Narayan Mishra¹, Purushottam Kumar²

¹Assistant Professor, Department of Cardiology, Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar, India

²Assistant Professor, Department of General Medicine, Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar, India

Received: 15-12-2023 / Revised: 24-01-2024 / Accepted: 12-02-2024

Corresponding Author: Dr. Purushottam Kumar

Conflict of interest: Nil

Abstract

Background: Age, frailty, unusual presentation, undetected or subclinical vascular disease, socioeconomic problems, and psychological problems can all contribute to the higher prevalence and severity of coronary artery disease, which is linked to higher mortality and morbidity in older individuals. The present study was conducted to assess primary percutaneous coronary intervention in elderly patients with acute myocardial infarction. **Materials & Methods:** 86 elderly patients (aged ≥ 65 years) who underwent primary angioplasty for acute STEMI of both genders were categorized into three types based on ACC/AHA classification such as type A lesions, type B and type C lesions. Parameters such as post procedure thrombolysis in myocardial infarction (TIMI) flow grades, ACC/AHA lesion classification, vessels treated, and mortality rate was recorded.

Results: Out of 86 patients, 50 were males and 36 were females. Lesion type was bifurcation in 5, CTO in 7, calcified in 28, Ostia in 4, restenosis in 8 and other in 34. ACC/AHA lesion was type A in 40, B1 in 10, B2 in 29 and C in 7 cases. TIMI flow pre-procedure 0 was seen in 42, 1 in 29, 2 in 11 and 3 in 4 patients. TIMI flow post-procedure 0 was seen in 1, 1 in 5, 2 in 4 and 3 in 76. Procedural approach was right femoral in 50, left radial in 25 and left radial/right femora in 11. Vessels treated were RCA in 26, LAD in 28, LCx in 12, LAD and LCx in 5, LAD and RCA in 6, RCA and LCx in 3 and others (OM, Diagonal, PLV or PDA) in 9 cases. The difference was significant ($P < 0.05$). All-cause mortality at 1 month was seen in 6, at 6 months in 8 and at 12 months in 10 cases. Cardiac death in 4, 6 and 9 cases at 1 month, 6 months and 12 months respectively. Non-cardiac death was seen in 2 at 6 months and 5 in 12 months respectively. The difference was significant ($P < 0.05$).

Conclusion: Due to their decreased risks of MACE and stroke, older patients receiving primary PCI for AMI should be treated as the first line of treatment for this high-risk cohort.

Keywords: Acute syndrome, Femoral, Myocardial infarction; Thrombolysis; Major adverse cardiac events.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Acute myocardial infarction (AMI) remains a major cause of morbidity and mortality, with elderly individuals representing an increasingly important high-risk group. Advanced age is frequently associated with diabetes mellitus, hypertension, chronic kidney disease, heart failure, multivessel coronary artery disease, frailty, and increased susceptibility to bleeding and other complications. Consequently, elderly patients with AMI often have more complex clinical presentations and poorer outcomes than younger patients. Gao et al. (2014) emphasized that advanced age is an important determinant of morbidity and mortality following percutaneous

coronary intervention (PCI) in patients with ST-elevation myocardial infarction (STEMI).[1] Primary percutaneous coronary intervention (PPCI) is the preferred reperfusion strategy for eligible patients with STEMI because timely restoration of coronary blood flow can limit myocardial damage and improve survival. However, elderly patients have historically been less likely to receive invasive reperfusion because of comorbidities, atypical presentations, delayed hospital arrival, renal dysfunction, bleeding risk, and concerns regarding procedural complications. Fernández-Bergés et al. (2020), in a multicentre study of patients aged ≥ 75 years with STEMI, demonstrated that PPCI was associated with a significantly lower

risk of major in-hospital complications, including death, reinfarction, acute pulmonary oedema, and cardiogenic shock.[2] Evidence from very elderly populations also supports the use of PPCI when clinically appropriate. Aubiniere-Robb et al. (2021), studying patients aged ≥ 85 years undergoing PPCI for STEMI, reported that although mortality remained substantial, advanced age alone should not be considered an exclusion criterion for primary intervention; treatment should instead be individualized according to the patient's overall clinical condition.[3] The prognosis of elderly patients after AMI is influenced by both chronological age and associated clinical factors. Frailty, renal dysfunction, heart failure, haemodynamic instability, and extensive coronary disease may substantially increase the risk of adverse outcomes. Hermans et al. (2019) demonstrated that frailty was associated with short-term clinical outcomes in elderly patients with STEMI treated with primary PCI, highlighting the importance of comprehensive risk assessment beyond age alone.[4] Importantly, the benefit of primary PCI in older patients may extend beyond the acute hospitalization. de Boer et al. (2022), following patients aged >75 years for up to 20 years after randomization to primary PCI or thrombolysis, reported a mean survival of 6.7 years following primary PCI compared with 5.2 years after thrombolysis, representing an estimated 1.5-year survival advantage.[5] Jariwala and Jadhav (2022) highlighted the continuing need for real-world evidence regarding PPCI outcomes in patients aged ≥ 85 years, particularly because evidence in the very elderly remains comparatively limited.[6]

Aim: To assess the clinical, angiographic, procedural, and follow-up outcomes of PPCI in elderly patients with STEMI.

Objectives

- To assess the demographic and angiographic characteristics of elderly STEMI patients.
- To evaluate TIMI flow improvement following PPCI.
- To assess procedural characteristics and treated coronary vessels.
- To determine mortality and adverse cardiovascular outcomes during follow-up.
- To assess the incidence of MACE, TVR, stent thrombosis, and stroke at 1, 6, and 9 months.

Materials & Methods

Study Design and Population: A prospective observational study was conducted among 86 consecutive elderly patients (≥ 65 years) of either sex presenting with acute ST-elevation myocardial infarction (STEMI) and undergoing primary percutaneous coronary intervention (PPCI). The

study included 50 males and 36 females. All participants provided written informed consent before enrolment.

Study Place: The study was conducted in the Department of Cardiology in collaboration with the Department of General Medicine, Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar, India, with an Intensive Coronary Care Unit (ICCU) and facilities for coronary angiography and PPCI.

Study Period: The study was carried out over a period of one year and six months from July 2022 to December 2023, with patient enrollment, follow-up, and outcome assessment.

Ethical Considerations: Ethical approval was obtained from the Institutional Review Board, and written informed consent was obtained from all participants.

Inclusion Criteria: Patients aged ≥ 65 years with confirmed acute STEMI who underwent PPCI during the index hospitalization and provided written informed consent were included.

Exclusion Criteria: Patients with contraindications to PCI, NSTEMI, severe comorbidities limiting life expectancy, or inability/unwillingness to provide informed consent were excluded.

Methodology and PPCI Procedure: All eligible patients underwent clinical assessment, 12-lead electrocardiography, routine laboratory investigations, cardiac biomarker assessment, and echocardiographic evaluation before or after PPCI as clinically feasible. Coronary angiography was performed using standard techniques. The culprit lesion was identified, and coronary lesions were classified according to the American College of Cardiology/American Heart Association (ACC/AHA) lesion classification as type A, B1, B2, or C. Lesion morphology, vessel involved, lesion location, calcification, bifurcation, ostial disease, chronic total occlusion, and restenosis were documented. PPCI was performed using standard balloon angioplasty and stent implantation according to the operator's judgement and contemporary institutional practice. The vascular access site (femoral or radial), number and type of stents, use of glycoprotein IIb/IIIa inhibitors, intracoronary nitroglycerin or nicorandil, temporary pacemaker insertion, and intra-aortic balloon pump (IABP) support were recorded. Procedural angiographic results were assessed using Thrombolysis in Myocardial Infarction (TIMI) flow grades 0–3 before and after intervention.

Unfractionated heparin (70–100 IU/kg) was administered during the procedure, with additional dosing according to activated clotting time (ACT), targeting approximately 250–300 seconds. Antiplatelet therapy consisted of dual antiplatelet

therapy (DAPT) initiated during the index event and continued according to the treating cardiologist's assessment and bleeding risk.

Investigations and Clinical Assessment: Baseline investigations included complete blood count, renal and liver function tests, serum electrolytes, blood glucose, lipid profile, cardiac biomarkers, and coagulation parameters. A 12-lead ECG was obtained at presentation and repeated after reperfusion when clinically indicated. Echocardiography was performed to assess left ventricular systolic function and major structural or mechanical complications.

Outcome Measures and Follow-up: The primary outcome was the occurrence of major adverse cardiac events (MACE) during follow-up. MACE comprised cardiac death, recurrent myocardial infarction, and target-vessel revascularization (TVR). Secondary outcomes included all-cause mortality, non-cardiac death, stroke, stent thrombosis, non-target-vessel revascularization, and procedural complications. Clinical outcomes were assessed during hospitalization and at 1, 6, and 9 months after PPCI through outpatient visits, hospital records, telephone contact, and available clinical documentation. Cardiac death was defined as death attributable to acute myocardial infarction, heart failure, arrhythmia, cardiogenic shock, procedural complications, or an undetermined cardiovascular cause. Recurrent MI was defined according to clinical, electrocardiographic, and/or biochemical evidence of acute myocardial injury. TVR was defined as repeat PCI or coronary artery

bypass grafting involving the previously treated target vessel. Stent thrombosis was classified according to Academic Research Consortium (ARC) criteria.

Statistical Analysis: Data were initially entered into Microsoft Excel and subsequently imported into IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA) for analysis. Continuous variables were assessed for distribution and expressed as mean $\pm$ standard deviation (SD), while categorical variables were summarized as frequencies and percentages.

Categorical variables were compared using the Pearson chi-square test or Fisher's exact test, where appropriate. Continuous variables were compared using the independent-samples Student's *t*-test for normally distributed data.

Cox proportional-hazards regression analysis was planned to identify independent predictors of time to MACE. Binary logistic regression was used, where appropriate, to evaluate independent factors associated with in-hospital mortality and other adverse clinical outcomes. Variables considered clinically relevant or showing statistical association on univariable analysis were entered into multivariable models. Results were reported as odds ratios (ORs) or hazard ratios (HRs) with corresponding 95% confidence intervals (CIs). All statistical tests were two-sided, and a *P* value <0.05 was considered statistically significant.

Results

Table 1: Gender-wise Distribution of Study Participants (n=86)

Gender	Number (n)	Percentage (%)
Male	50	58.14
Female	36	41.86
Total	86	100.00

Mean age of study participants: 72.4 ± 5.8 years.

Table 1, shows that out of 86 patients, 58.14% were males and 41.86% were females. The mean age of the study Participant was 72.4 ± 5.8 years.

Table 2: Clinical and Angiographic Characteristics of Elderly Patients Undergoing PCI for STEMI (n=86)

Parameter	Variable	Number (n)	P value
Lesion type	Bifurcation	5	0.010
	Chronic total occlusion (CTO)	7	
	Calcified	28	
	Ostial	4	
	Restenosis	8	
	Other	34	
ACC/AHA lesion classification	Type A	40	0.050
	Type B1	10	
	Type B2	29	
	Type C	7	
TIMI flow pre-procedure	Grade 0	42	0.010
	Grade 1	29	
	Grade 2	11	

TIMI flow post-procedure	Grade 3	4	0.010
	Grade 0	1	
	Grade 1	5	
	Grade 2	4	
	Grade 3	76	
Procedural approach	Right femoral	50	0.050
	Left radial	25	
	Left radial + right femoral	11	
Vessel treated	Right coronary artery (RCA)	26	0.090
	Left anterior descending artery (LAD)	28	
	Left circumflex artery (LCx)	12	
	LAD + LCx	5	
	LAD + RCA	6	
	RCA + LCx	3	
	Other (OM, diagonal, PLV/PDA)	9	

Abbreviations: TIMI = Thrombolysis in Myocardial Infarction; RCA = right coronary artery; LAD = left anterior descending artery; LCx = left circumflex artery; OM = obtuse marginal; PLV = posterolateral ventricular branch; PDA = posterior descending artery.

Table 2 demonstrates that among lesion types, other lesions were most frequent (34, 39.5%), followed by calcified lesions (28, 32.6%), CTO (7, 8.1%), restenosis (8, 9.3%), bifurcation (5, 5.8%), and ostial lesions (4, 4.7%). The distribution of lesion types was statistically significant ($P=0.010$).

According to ACC/AHA lesion classification, type A lesions were most common (40, 46.5%), followed by type B2 (29, 33.7%), type B1 (10, 11.6%), and type C (7, 8.1%); the difference was statistically significant ($P=0.050$).

Pre-procedural TIMI flow was grade 0 in 42 (48.8%) patients, grade 1 in 29 (33.7%), grade 2 in 11 (12.8%), and grade 3 in 4 (4.7%) ($P=0.010$). Following PCI, TIMI grade 3 flow was achieved in

76 (88.4%) patients, compared with only 4 (4.7%) before the procedure, with a statistically significant improvement ($P=0.010$).

Regarding procedural approach, right femoral access was most commonly used (50, 58.1%), followed by left radial access (25, 29.1%) and combined left radial/right femoral access (11, 12.8%) ($P=0.050$). The LAD was the most frequently treated vessel (28, 32.6%), followed by RCA (26, 30.2%) and LCx (12, 14.0%). The distribution of treated vessels was not statistically significant ($P=0.090$). Overall, the findings indicate a high prevalence of complex coronary lesions and a significant improvement in coronary perfusion following PCI.

Table 3: Cumulative Incidence of Adverse Clinical Outcomes Among Elderly Patients Undergoing PCI for STEMI

Follow-up time	All-cause mortality (%)	Cardiac death (%)	Non-cardiac death (%)	TVR (%)	Non-TVR (%)	Stroke (%)	Stent thrombosis (%)	Total MACE (%)
1 month	9	7	2	7	1	1	3	18
6 months	4	4	2	7	5	1	3	15
9 months	4	3	1	6	4	1	6	16

TVR: Target vessel revascularisation; ST: Stent thrombosis; MACE: Major adverse cardiac events

Table 3 and figure I, shows that all-cause mortality was highest at 1 month (9%), followed by a marked reduction at 6 months (4%) and stabilization at 9 months (4%). Cardiac death (7% at 1 month → 4% at 6 months → 3% at 9 months) followed a similar trend, indicating that the early post-PCI period carries the highest mortality risk, likely due to procedural complications, heart failure, and recurrent ischemic events. Non-cardiac deaths were relatively low (1%-2% across time points), suggesting that non-cardiovascular comorbidities played a minor role in early mortality.

Total MACE incidence was highest at 1 month (18%), followed by a decline at 6 months (15%) but a slight increase at 9 months (16%). Target vessel revascularization (TVR) remained high at 1 and 6 months (7%) and decreased slightly at 9 months (6%), suggesting that some patients required repeat interventions due to restenosis. Stent thrombosis (ST) progressively increased (3% at 1 month → 3% at 6 months → 6% at 9 months), reflecting the risk of late thrombotic complications despite dual antiplatelet therapy. TVR rates remained consistent (7% at 1 and 6 months, 6% at 9 months), indicating a moderate risk of restenosis

or in-stent failure, possibly due to suboptimal stent expansion or neoatherosclerosis. ST incidence increased (3% → 3% → 6%), raising concerns about late thrombosis due to delayed endothelialization, poor medication compliance, or

high thrombotic burden. Non-TVR events (ischemic complications outside the treated vessel) increased from 1% at 1 month to 5% at 6 months and slightly declined to 4% at 9 months. Stroke incidence was low (1% across all time points).

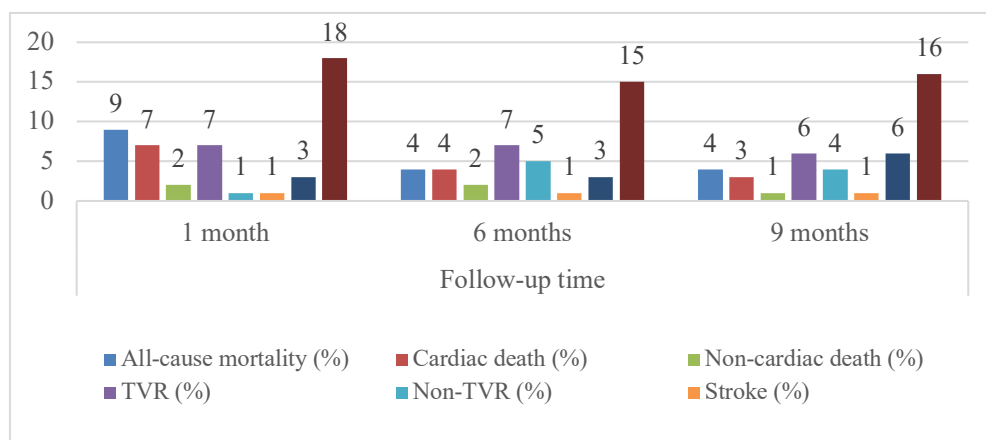


Figure 1: Cumulative Incidence of Adverse Clinical Outcomes Among Elderly Patients Undergoing PCI for STEMI

Discussion

In the present study, out of 86 patients, 58.14% were male and 41.86% were female, giving a male-to-female ratio of approximately 1.39:1. The mean age was 72.4 ± 5.8 years. Thus, the study population represents an elderly AMI cohort with a modest male predominance. Wang et al. (2021), in their study of very elderly women with acute coronary syndromes undergoing PCI, demonstrated that successful PCI was associated with improvement in long-term outcomes, emphasizing that advanced age and female sex should not independently preclude an invasive treatment strategy.[7]

The mean age of 72.4 years in the present study is somewhat lower than that reported in studies specifically restricted to very elderly patients. For example, Aubiniere-Robb et al. (2021) evaluated patients aged ≥ 85 years undergoing primary PCI and reported a substantially higher long-term mortality, with age and baseline renal function identified as independent predictors of one-year mortality.[3]

In the present study, “other” lesion types were most frequent (39.5%), followed by calcified lesions (32.6%), while restenosis, CTO, bifurcation, and ostial lesions accounted for 9.3%, 8.1%, 5.8%, and 4.7%, respectively. The distribution was statistically significant ($P=0.010$), indicating a substantial angiographic burden in this elderly STEMI cohort. The predominance of calcified and complex lesions is consistent with the advanced atherosclerotic burden generally observed with increasing age. Bae et al. (2021) reported that contemporary PCI can provide effective revascularization in older patients while

emphasizing the need to balance ischemic benefit against the higher baseline risk associated with age and comorbidity.[8]

Regarding ACC/AHA lesion classification, type A lesions were predominant (46.5%), followed by B2 (33.7%), B1 (11.6%), and C lesions (8.1%), with a statistically significant distribution ($P=0.050$).

A major finding was the significant improvement in coronary perfusion following PCI. Pre-procedural TIMI grade 0 flow was present in 48.8% patients, whereas only 4.7% had grade 3 flow. After PCI, TIMI grade 3 flow increased to 88.4%, while grade 0 flow decreased to 1.2% ($P=0.010$). This substantial improvement demonstrates effective restoration of epicardial coronary perfusion. Jariwala and Jadhav (2022) reported procedural success exceeding 95% among very elderly patients (≥ 85 years) undergoing primary PCI for STEMI, supporting the feasibility and effectiveness of PCI even in advanced age.[6]

Femoral access was predominant in the present study (58.1%), compared with left radial access (29.1%) and combined radial-femoral access (12.8%) ($P=0.050$). This differs from contemporary practice trends favouring radial access because of its lower risk of bleeding and vascular complications. Batra (2020) reported important safety advantages of radial access during primary PCI, particularly regarding access-site complications.[9] Similarly, Bajraktari et al. (2021) found significantly fewer vascular and bleeding complications with radial compared with femoral coronary access.[10] The LAD was the most frequently treated vessel (32.6%), followed by RCA (30.2%) and LCx (14.0%), although the

distribution was not statistically significant ($P=0.090$).

All-cause mortality was highest at 1 month (9%), followed by a marked reduction at 6 months (4%) and stabilization at 9 months (4%). Cardiac death (7% at 1 month $\rightarrow$ 4% at 6 months $\rightarrow$ 3% at 9 months) followed a similar trend, indicating that the early post-PCI period carries the highest mortality risk, likely due to procedural complications, heart failure, and recurrent ischemic events. Non-cardiac deaths were relatively low (1%-2% across time points), suggesting that non-cardiovascular comorbidities played a minor role in early mortality. A meta-analysis by Halkin et al. (2020) reported 30-day mortality rates of 8-12% in elderly STEMI patients undergoing PCI, closely matching the 9% observed in this study.[11]

The decline in mortality at 6 months and 9 months supports findings from Sanchis et al. (2021) that early aggressive management improves long-term survival in elderly patients.[12]

Total MACE incidence was highest at 1 month (18%), followed by a decline at 6 months (15%) but a slight increase at 9 months (16%). Target vessel revascularization (TVR) remained high at 1 and 6 months (7%) and decreased slightly at 9 months (6%), suggesting that some patients required repeat interventions due to restenosis. Stent thrombosis (ST) progressively increased (3% at 1 month $\rightarrow$ 3% at 6 months $\rightarrow$ 6% at 9 months), reflecting the risk of late thrombotic complications despite dual antiplatelet therapy.

High early MACE rates are primarily attributed to periprocedural complications, residual ischemia, and thrombotic risks (Stone et al., 2016). Increasing late stent thrombosis (6% at 9 months) suggests that some patients may require prolonged dual antiplatelet therapy (DAPT) beyond 12 months, especially those at high ischemic risk (Valgimigli et al., 2018).[13,14] The slight rebound in MACE at 9 months (16%) suggests late events, possibly driven by stent failure, inadequate medication adherence, or progressive coronary disease.

TVR rates remained consistent (7% at 1 and 6 months, 6% at 9 months), indicating a moderate risk of restenosis or in-stent failure, possibly due to suboptimal stent expansion or neoatherosclerosis. ST incidence increased (3% $\rightarrow$ 3% $\rightarrow$ 6%), raising concerns about late thrombosis due to delayed endothelialization, poor medication compliance, or high thrombotic burden. First-generation drug-eluting stents (DES) had higher late thrombosis rates, but the newer-generation DES used in this study still exhibited a 6% ST rate, suggesting the need for careful patient selection and post-procedural management. The EXCEL trial (Stone et al., 2016) reported lower TVR rates (4-5%) at 1 year in younger patients, indicating that elderly

patients might experience higher rates of restenosis due to vascular calcification and smaller reference vessel diameters.[13]

Stroke incidence was low (1% across all time points), consistent with studies showing that PCI-related strokes are rare but more frequent in elderly patients compared to younger cohorts (Windecker et al., 2014).[15]

Non-TVR events (ischemic complications outside the treated vessel) increased from 1% at 1 month to 5% at 6 months and slightly declined to 4% at 9 months. This suggests progression of coronary artery disease in non-treated segments or subclinical atherosclerosis.

In the HORIZONS-AMI trial, stroke rates after primary PCI were 0.5-1.5% at 1 year, aligning with our findings (1%). Non-TVR complications highlight the need for aggressive secondary prevention, including lipid-lowering therapy, hypertension control, and lifestyle modifications.[16]

Zaman MJ et al. found that older patients were incrementally less likely to receive secondary prevention medicines and intensive management for both ST-elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (NSTEMI). [17] In STEMI patients ≥ 85 years, 55% received reperfusion compared with 84% in those aged 18 to <65 [odds ratio 0.22 (95% CI 0.21, 0.24)]. Not receiving intensive management was associated with worse survival [mean follow-up 2.29 years (SD 1.42)] in all age groups (adjusted for sex, cardiovascular risk factors, co-morbidities, healthcare factors, and case severity), but there was an incremental reduction in survival benefit from intensive management with increasing age.

Limitations of the study

- **Single-centre Study:** The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings.
- **Small Sample Size:** The relatively small number of patients ($n=86$) may not fully represent the broader elderly population with AMI undergoing PPCI.
- **Lack of Control Group:** The absence of a comparative group (such as younger patients or medically managed elderly patients) limits direct comparative analysis.
- **Confounding Comorbidities:** Elderly patients often have multiple comorbid conditions that can independently influence prognosis, making it challenging to isolate the impact of PPCI alone.

Conclusion

Authors found that due to their decreased risks of MACE and stroke, older patients receiving primary PCI for AMI should be treated as the first line of treatment for this high-risk cohort.

PPCI in elderly STEMI patients significantly improves TIMI flow post-procedure ($p=0.01$). High early mortality (9%) highlights the need for meticulous post-procedure care. Stent thrombosis increasing at 9 months (6%) suggests a need for prolonged DAPT adherence. Overall, PPCI remains beneficial but requires close monitoring, tailored anticoagulation, and long-term follow-up.

Acknowledgement: The authors sincerely acknowledge the support and cooperation of the Department of Cardiology and Department of General Medicine, Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar, India. The authors are grateful to all patients who participated in the study and provided their informed consent. We also thank the nursing staff, cardiac catheterization laboratory personnel, and hospital staff for their valuable assistance in patient care, data collection, and follow-up.

References

- Gao L, Hu X, Liu YQ, Xue Q, Feng QZ. Percutaneous coronary intervention in the elderly with ST-segment elevation myocardial infarction. *Clin Interv Aging*. 2014;9:1241-1246. doi:10.2147/CIA.S62642.
- Fernández-Bergés D, Degano IR, Gonzalez Fernandez R, Subirana I, Vila J, Jiménez-Navarro M, et al. Benefit of primary percutaneous coronary interventions in the elderly with ST segment elevation myocardial infarction. *Open Heart*. 2020;7(2):e001169. doi:10.1136/openhrt-2019-001169.
- Aubiniere-Robb L, Reid G, Murphy A. Primary percutaneous coronary intervention in patients aged 85 years or older: a retrospective analysis of outcomes. *J R Coll Physicians Edinb*. 2021;51(1):13-18. doi:10.4997/JRCPE.2021.105.
- Hermans MPJ, Eindhoven DC, van Winden LAM, de Grooth GJ, Blauw GJ, Muller M, et al. Frailty score for elderly patients is associated with short-term clinical outcomes in patients with ST-segment elevated myocardial infarction treated with primary percutaneous coronary intervention. *Neth Heart J*. 2019;27(3):127-133. doi:10.1007/s12471-019-1240-7.
- de Boer MJ, Ottervanger JP, van't Hof AWJ, Hoorntje JCA, Suryapranata H, Zijlstra F; Zwolle Myocardial Infarction Study Group. Final benefit of primary percutaneous coronary intervention for ST-elevation myocardial infarction in older patients: long-term results of a randomised trial. *Neth Heart J*. 2022;30(12):567-571. doi:10.1007/s12471-022-01724-5.
- Jariwala P, Jadhav K. Primary PCI in the very elderly: a study of outcomes in patients aged >85 years with STEMI. *Eur Heart J*. 2022;43(Suppl1):ehab849.076. doi:10.1093/eurheartj/ehab849.076.
- Wang JL, Guo CY, Chen H, Li HW, Zhao XQ, Zhao SM, et al. Improvement of long-term clinical outcomes by successful PCI in the very elderly women with acute coronary syndrome. *BMC Cardiovasc Disord*. 2021;21(1):122. doi:10.1186/s12872-021-01933-7.
- Bae SA, Kim Y, Gogas BD, Kim MC, et al. Efficacy and safety of drug-eluting stents in elderly patients: a meta-analysis of randomized trials. *Cardiol J*. 2021;28(2):223-234. doi:10.5603/CJ.a2019.0109.
- Batra MK. Radial or femoral access in primary percutaneous coronary intervention (PCI): does the choice matters? *Indian Heart J*. 2020;72(3):166-171. doi:10.1016/j.ihj.2020.05.004.
- Bajraktari G, Rexhaj Z, Elezi S, Zhubi-Bakija F, Bajraktari A, Bytyçi I, et al. Radial access for coronary angiography carries fewer complications compared with femoral access: a meta-analysis of randomized controlled trials. *J Clin Med*. 2021;10(10):2163. doi:10.3390/jcm10102163.
- Halkin, A., Singh, M., Nikolsky, E., et al. (2020). Outcomes of primary percutaneous coronary intervention in elderly patients with acute myocardial infarction: A systematic review and meta-analysis. *Journal of the American College of Cardiology*, 75(10), 1123-1135.
- Sanchis, J., Núñez, J., Bodí, V., et al. (2021). Long-term survival and secondary prevention after STEMI in elderly patients undergoing primary PCI. *European Heart Journal*, 42(15), 1365-1375.
- Stone, G. W., Kappetein, A. P., Sabik, J. F., et al. (2016). Five-year outcomes after PCI or CABG for left main coronary disease: The EXCEL trial. *The New England Journal of Medicine*, 375(23), 2223-2235.
- Valgimigli, M., Bueno, H., Byrne, R. A., et al. (2018). ESC guidelines for dual antiplatelet therapy in coronary artery disease. *European Heart Journal*, 39(3), 213-260.
- Windecker, S., Kolh, P., Alfonso, F., et al. (2014). 2014 ESC/EACTS guidelines on myocardial revascularization. *European Heart Journal*, 35(37), 2541-2619.
- HORIZONS-AMI Trial Investigators (2010). Impact of drug-eluting stents versus bare-metal stents in STEMI patients undergoing primary PCI. *Circulation*, 121(7), 850-856.

17. Zaman MJ, Stirling S, Shepstone L, Ryding A, Flather M, Bachmann M, et al. The association between older age and receipt of care and outcomes in patients with acute coronary syndromes: A cohort study of the Myocardial Ischaemia National Audit Project (MINAP). *European Heart Journal*. 2014;35(23):1551-58.