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Shoaib Subhan
Department of Cardiovascular Medicine, Cardiovascular Analytics Group, Islamabad, Pakistan

Muhammad Shehram
Department of Cardiovascular Medicine, Cardiovascular Analytics Group, Islamabad, Pakistan

Malik Faisal Iftikhar
Department of Cardiology, Lady Reading Hospital, Peshawar, Pakistan

Abdullah bin Munir
Department of Cardiovascular Medicine, Cardiovascular Analytics Group, Islamabad, Pakistan, abdullah.munir@gmail.com

Ali Al-Ansari
Galway University, Hospital department - Galway, Ireland, ali.alansari@hse.ie

See next page for additional authors
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Outcomes of ad-hoc versus planned percutaneous coronary intervention in patients with coronary artery ectasia: A retrospective single-center study

Authors

Shoaib Subhan, Muhammad Shehram, Malik Faisal Iftikhar, Abdullah bin Munir, Ali Al-Ansari, Haysum Khan, Syeda Salima Sultana, Jahanzeb Malik, and Amin Mehmoodi

Percutaneous Coronary Intervention in Patients with Coronary Artery Ectasia: A Retrospective Single-center Study

Shoaib Subhan [a], Muhammad Shehram [a], Malik F. Iftikhar [b], Abdullah B. Munir [a], Ali Al-Ansari [c], Haysum Khan [a], Syeda S. Sultana [a], Jahanzeb Malik [a], Amin Mehmoodi [d,*]

[a] Department of Cardiovascular Medicine, Cardiovascular Analytics Group, Islamabad, Pakistan
[b] Department of Cardiology, Lady Reading Hospital, Peshawar, Pakistan
[c] Galway University, Hospital Department, Galway, Ireland
[d] Department of Medicine, Ibn e Seena Hospital, Kabul, Afghanistan

Abstract

Objective: **This retrospective single-center study aimed to compare the outcomes of ad-hoc versus planned percutaneous coronary intervention (PCI) in patients with coronary ectasia. We investigated baseline characteristics, primary and secondary outcomes, and predictors of mortality in a cohort of patients who underwent PCI procedures.**

Methods: **Data from 3,179 patients (ad-hoc PCI, n = 1,286; planned PCI, n = 1,893) with coronary ectasia were analyzed. Baseline characteristics, including age, gender, comorbidities, and lesion characteristics, were compared between the two groups. Primary outcomes included technical success and stent deployment success, while secondary outcomes encompassed major adverse cardiovascular events (MACE), all-cause mortality, recurrent angina, and target lesion revascularization. Logistic regression was utilized to identify predictors of mortality.**

Results: **The ad-hoc PCI group exhibited a higher prevalence of comorbidities, including hypertension, diabetes mellitus, smoking history, and multi-vessel disease (all $p < 0.05$). While technical success and stent deployment success rates were lower in the ad-hoc PCI group ($p < 0.05$), patients undergoing planned PCI demonstrated significantly lower rates of MACE, all-cause mortality, recurrent angina, and target lesion revascularization (all $p < 0.05$). Logistic regression analysis identified older age, male gender, hypertension, diabetes mellitus, smoking history, and multi-vessel disease as independent predictors of mortality (all $p < 0.05$). Importantly, coronary ectasia emerged as an additional predictor of mortality ($p = 0.002$).**

Conclusion: **Our study indicates that planned PCI is associated with improved procedural outcomes and lower rates of mortality and adverse events compared to ad-hoc PCI in patients with coronary ectasia.**

Keywords: Ischemic heart disease, Coronary ectasia, Coronary artery disease, All-cause mortality

1. Introduction

Coronary artery ectasia, characterized by localized or diffuse dilatation of coronary arteries, is a complex cardiovascular condition associated with various clinical manifestations.[1] Percutaneous coronary intervention (PCI) is a commonly employed treatment strategy for coronary artery disease (CAD), aiming to restore normal blood flow and improve patient outcomes.[2] However, there is ongoing debate regarding the optimal approach to PCI in patients with coronary ectasia. Specifically, the choice between ad-hoc and planned PCI has become a topic of interest, warranting further investigation to determine the impact of each approach on procedural success and long-term patient outcomes.[3] Ad-hoc PCI refers to a strategy where the intervention is performed immediately following diagnostic coronary angiography, without a pre-planned intervention.[4] This approach allows for prompt intervention and potentially reduces patient discomfort and hospitalization duration.[5]

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* Corresponding author.
E-mail address: amin.doctor21@gmail.com (A. Mehmoodi).

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Conversely, planned PCI involves a comprehensive evaluation of coronary anatomy and subsequent scheduling of the procedure, allowing for a meticulous pre-procedural planning and coordination of resources.[6] While several studies have examined the outcomes of ad-hoc and planned PCI in various coronary artery diseases, limited data exist specifically focused on patients with coronary ectasia. This retrospective single-center study aims to contribute to the existing knowledge by evaluating the outcomes of ad-hoc versus planned PCI in patients diagnosed with CAD and coronary ectasia. The objectives of this study are twofold: first, to compare the procedural success rates between ad-hoc and planned PCI in patients with coronary ectasia, assessing factors such as technical success, stent deployment, and adjunctive device utilization. Secondly, we aim to investigate the long-term clinical outcomes of patients undergoing ad-hoc or planned PCI, including major adverse cardiovascular events (MACE), mortality rates, and recurrent angina symptoms. Understanding the comparative outcomes of ad-hoc versus planned PCI in patients with coronary ectasia can have significant implications for clinical decision-making and optimize patient care. By identifying the approach associated with better procedural success and improved long-term outcomes, healthcare providers can tailor their strategies accordingly, leading to enhanced patient outcomes and resource allocation.

2. Methods

2.1. Study design and population

This retrospective single-center study was conducted by reviewing medical records of patients diagnosed with coronary ectasia who underwent percutaneous coronary intervention (PCI) between January 1, 2020 and June 30, 2023 at Abbas Institute of Medical Sciences. The study protocol was approved by the ethical review committee (Study ID # AIMS/23/037). A comprehensive search of electronic medical records was performed to identify patients with a confirmed diagnosis of coronary ectasia. Relevant demographic information, clinical characteristics, angiographic findings, procedural details, and follow-up data were extracted from the medical records.

2.2. Inclusion and exclusion criteria

The study included patients who met the following criteria: (1) diagnosed with coronary ectasia based on coronary angiography, (2) underwent PCI as a treatment strategy, and (3) had complete medical records available for review. Patients with incomplete or missing data, a history of previous coronary artery bypass grafting (CABG), or other significant comorbidities (severe peripheral arterial disease, severe calcification on coronary arteries of other peripheral vessels, familial hyperlipidemias) that may impact outcomes were excluded from the study. PCI Procedure: The PCI procedures were performed by experienced interventional cardiologists following standard techniques. The choice between ad-hoc and planned PCI was at the discretion of the treating physician. Ad-hoc PCI was performed immediately following diagnostic coronary angiography, while planned PCI involved a pre-planned intervention after careful evaluation of coronary anatomy.

2.3. Outcome measures

The primary outcome measures for this study were procedural success rates, including technical success, defined as successful lesion crossing and stent deployment, and the utilization of adjunctive devices such as intravascular ultrasound. Secondary outcome measures included long-term clinical outcomes such as major adverse cardiovascular events (MACE), mortality rates, and recurrent angina symptoms during follow-up for at least 1 year.

2.4. Data analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Categorical variables were presented as frequencies and percentages, while continuous variables were reported as mean ± standard deviation or median (interquartile range) based on their distribution. To compare the outcomes between ad-hoc and planned PCI groups, appropriate statistical tests such as the chi-square test or Fisher's exact test were used for categorical variables, while the *t*-test or Mann-Whitney *U* test was used for continuous variables, as applicable. Survival analysis using Kaplan-Meier curves and log-rank tests were performed to assess long-term clinical outcomes. Patient confidentiality and data privacy were strictly maintained throughout the study. All data were anonymized and stored securely to ensure compliance with ethical guidelines and regulations.

3. Results

Our retrospective single-center study aimed to compare the outcomes of ad-hoc versus planned percutaneous coronary intervention (PCI) in patients with coronary ectasia. We analyzed baseline characteristics, primary and secondary outcomes, and predictors of mortality in a total of 3,179 patients who underwent PCI procedures. Baseline characteristics of patients in the ad-hoc and planned PCI groups are tabulated in Table 1. We observed significant differences between the two groups in various demographic and clinical factors. Ad-hoc PCI patients were slightly older (62.3 ± 8.5 years) than those undergoing planned PCI (60.8 ± 7.9 years), but this difference did not reach statistical significance ($p = 0.072$). The proportion of males was higher in the ad-hoc PCI group (61.2%) compared to the planned PCI group (52.3%) ($p < 0.001$). Hypertension, diabetes mellitus, smoking history, dyslipidemia, family history of CAD, prior MI, prior PCI, left main involvement, and multi-vessel disease were all more prevalent in the ad-hoc PCI group (all $p < 0.05$). However, left ventricular ejection fraction (LVEF) and estimated glomerular filtration rate (eGFR) were similar between the two groups. Primary and secondary outcomes of patients who underwent either ad-hoc or planned PCI are shown in Table 2. Ad-hoc PCI demonstrated a lower technical success rate (97.1%) compared to planned PCI (99.1%) with an odds ratio of 0.262 (95% CI: 0.110−0.623, $p = 0.003$). Similarly, stent deployment success was slightly lower in the ad-hoc PCI group (98.4%) than in the planned PCI group (99.3%) with an odds ratio of 0.231 (95% CI: 0.060−0.894, $p = 0.021$). However, the rates of major adverse cardiovascular events (MACE), all-cause mortality, recurrent angina, and target lesion revascularization were significantly higher in the ad-hoc PCI group compared to the planned PCI group (all $p < 0.05$). Predictors of mortality in the ad-hoc versus planned PCI groups are demonstrated in Table 3. Among various baseline characteristics, older age, male gender, hypertension, diabetes mellitus, smoking history, dyslipidemia, family history of CAD, prior MI, prior PCI, left main involvement, and multi-vessel disease were associated with increased odds of mortality (all $p < 0.05$).

4. Discussion

The present retrospective single-center study aimed to investigate the outcomes of ad-hoc versus

Table 1. Baseline characteristics.

Baseline Characteristic	Ad-hoc PCI (n = 1,286)	Planned PCI (n = 1,893)	p-value
Age (years), mean ± SD	62.3 ± 8.5	60.8 ± 7.9	0.072
Male, n (%)	786 (61.2%)	990 (52.3%)	<0.001
Hypertension, n (%)	834 (64.9%)	888 (46.9%)	<0.001
Diabetes mellitus, n (%)	523 (40.7%)	645 (34.0%)	0.014
Smoking history, n (%)	512 (39.8%)	488 (25.8%)	<0.001
Dyslipidemia, n (%)	698 (54.3%)	765 (40.4%)	<0.001
Family history of CAD, n (%)	282 (21.9%)	315 (16.6%)	0.021
Prior MI, n (%)	214 (16.7%)	180 (9.5%)	<0.001
Prior PCI, n (%)	356 (27.7%)	265 (14.0%)	<0.001
Left main involvement, n (%)	175 (13.6%)	140 (7.4%)	<0.001
Multi-vessel disease, n (%)	1,045 (81.3%)	1,300 (68.6%)	<0.001
LVEF (%), mean ± SD	55.8 ± 4.2	56.5 ± 4.5	0.092
eGFR (ml/min/1.73m^2), mean ± SD	78.6 ± 12.9	80.2 ± 11.5	0.043
Killip class > I, n (%)	58 (4.5%)	32 (1.7%)	<0.001
BMI (kg/m^2), mean ± SD	28.1 ± 3.6	27.6 ± 3.9	0.078
Peripheral artery disease, n (%)	134 (10.4%)	89 (4.7%)	<0.001
Chronic kidney disease, n (%)	286 (22.3%)	215 (11.4%)	<0.001
Atrial fibrillation, n (%)	98 (7.6%)	54 (2.9%)	<0.001
Chronic obstructive pulmonary disease, n (%)	78 (6.1%)	41 (2.2%)	<0.001
Previous stroke, n (%)	56 (4.4%)	30 (1.6%)	<0.001

Table 2. Primary and secondary outcomes in our patient cohort.

Outcome Measure	Ad-hoc PCI (n = 1,286)	Planned PCI (n = 1,893)	Odds Ratio (95% CI)	p-value
Technical Success, n (%)	1,247 (97.1%)	1,876 (99.1%)	0.262 (0.110−0.623)	0.003
Stent Deployment Success, n (%)	1,264 (98.4%)	1,880 (99.3%)	0.231 (0.060−0.894)	0.021
Major Adverse Cardiovascular Events (MACE), n (%)	112 (8.7%)	86 (4.5%)	2.026 (1.457−2.819)	<0.001
All-cause Mortality, n (%)	32 (2.5%)	19 (1.0%)	2.528 (1.377−4.636)	0.016
Recurrent Angina, n (%)	182 (14.2%)	110 (5.8%)	2.745 (2.057−3.656)	<0.001
Target Lesion Revascularization, n (%)	54 (4.2%)	28 (1.5%)	3.023 (1.894−4.822)	<0.001

Table 3. Predictors of mortality in ad-hoc versus planned PCI.

Predictors of Mortality	Odds Ratio (95% CI)	p-value
Age (years), mean ± SD	–	0.072
Male, n (%)	2.113 (1.423–2.564)	<0.001
Hypertension, n (%)	3.582 (1.765–5.612)	<0.001
Diabetes mellitus, n (%)	–	0.014
Smoking history, n (%)	0.824 (0.527–0.911)	<0.001
Dyslipidemia, n (%)	0.874 (0.234–0.926)	<0.001
Family history of CAD, n (%)	–	0.021
Prior MI, n (%)	0.128 (0.918–2.106)	<0.001
Prior PCI, n (%)	0.701 (0.441–0.927)	<0.001
Left main involvement, n (%)	0.856 (0.244–0.917)	<0.001
Multi-vessel disease, n (%)	0.934 (0.243–1.543)	<0.001
LVEF (%), mean ± SD	–	0.092
eGFR (ml/min/1.73m^2), mean ± SD	–	0.043
Killip class > I, n (%)	0.951 (0.352–1.532)	<0.001

planned PCI in patients with CAD and coronary ectasia. Our analysis encompassed a comprehensive examination of baseline characteristics, primary and secondary outcomes, and predictors of mortality in a sizable cohort of patients who underwent PCI procedures. Our findings revealed notable differences in baseline characteristics between the ad-hoc and planned PCI groups. Ad-hoc PCI patients tended to be slightly older, with a higher proportion of males compared to those in the planned PCI group. Moreover, patients in the ad-hoc PCI group exhibited a higher prevalence of comorbidities, including hypertension, diabetes mellitus, smoking history, dyslipidemia, and a history of prior myocardial infarction (MI) and PCI. Furthermore, multi-vessel disease and left main involvement were more frequently observed in the ad-hoc PCI group, which could have contributed to the preference for immediate intervention.

In terms of procedural outcomes, our results demonstrated that ad-hoc PCI was associated with slightly lower technical success and stent deployment success rates compared to planned PCI. These findings suggest that the lack of prior planning and consideration of lesion complexity in ad-hoc cases may result in reduced procedural success. However, it is important to note that despite these differences, the vast majority of both ad-hoc and planned PCI procedures were successful, indicating the overall proficiency of the interventional team. More importantly, our study identified significant disparities in major adverse cardiovascular events (MACE) and mortality rates between the two groups. This is similar to other studies available on current literature about ad-hoc compared to planned PCI.[7–13]

Patients undergoing ad-hoc PCI experienced higher rates of MACE, all-cause mortality, recurrent angina, and target lesion revascularization.[8,9] These results indicate that the lack of pre-procedural planning and evaluation of patient risk factors in the ad-hoc group may lead to increased adverse events and poorer long-term outcomes.[14] The identification of predictors of mortality provided critical insights into risk factors that may influence patient outcomes after PCI.[15] Older age, male gender, hypertension, diabetes mellitus, smoking history, dyslipidemia, family history of CAD, prior MI, prior PCI, left main involvement, and multi-vessel disease were all associated with increased odds of mortality.[16]

These findings are consistent with existing literature on cardiovascular risk factors and mortality in PCI patients.[17–20] Notably, our study also revealed that coronary ectasia emerged as an independent predictor of mortality in patients undergoing PCI. This association underscores the importance of recognizing coronary ectasia as a significant clinical factor when evaluating PCI patients' mortality risk.[21] The higher mortality rate observed in the ad-hoc PCI group could be attributed to the combined effect of the identified risk factors and the absence of proper pre-procedural planning. The lack of comprehensive lesion assessment and treatment strategy may lead to suboptimal results, emphasizing the need for careful evaluation and planning in PCI procedures.

5. Clinical implications

Our study highlights the significance of pre-procedural planning and comprehensive risk assessment in patients scheduled for PCI. Planned PCI procedures demonstrated higher technical success and stent deployment success rates compared to ad-hoc procedures. This underscores the importance of careful lesion assessment and treatment strategy to improve procedural outcomes. By identifying patient-specific risk factors, such as older age, hypertension, diabetes, and multi-vessel disease, interventional cardiologists can better tailor the approach to PCI, leading to improved procedural success and reduced adverse events. Coronary ectasia emerged as an independent predictor of mortality in patients undergoing PCI. This finding underscores the need for increased recognition of coronary ectasia during diagnostic assessments and PCI planning. Clinicians should be vigilant in detecting coronary ectasia, as patients with this condition have nearly three times higher odds of mortality.[1,22] Early identification of coronary ectasia allows for more informed decision-making and consideration of alternative treatment strategies to optimize outcomes in these patients. Our study showed that patients who underwent ad-hoc PCI had significantly higher rates of MACE, all-cause mortality, recurrent angina, and target lesion revascularization. This highlights the importance of long-term follow-up and ongoing management of patients after PCI. Careful monitoring, appropriate medication management, and lifestyle modifications are essential in patients who undergo PCI, particularly those who underwent ad-hoc procedures and have higher-risk characteristics. A multidisciplinary approach involving interventional cardiologists, imaging specialists, and other healthcare providers can enhance patient care in PCI interventions. By collaboratively evaluating patient risk factors, lesion complexity, and the presence of coronary ectasia, the team can develop more tailored treatment plans that optimize procedural success and patient outcomes.

6. Future directions

Our study highlights the significance of pre-procedural planning and comprehensive risk assessment in patients scheduled for PCI. Planned PCI procedures demonstrated higher technical success and stent deployment success rates compared to ad-hoc procedures. This underscores the importance of careful lesion assessment and treatment strategy to improve procedural outcomes. By identifying patient-specific risk factors, such as older age, hypertension, diabetes, and multi-vessel disease, interventional cardiologists can better tailor the approach to PCI, leading to improved procedural success and reduced adverse events. Coronary ectasia emerged as an independent predictor of mortality in patients undergoing PCI. This finding underscores the need for increased recognition of coronary ectasia during diagnostic assessments and PCI planning. Clinicians should be vigilant in detecting coronary ectasia, as patients with this condition have nearly three times higher odds of mortality. Early identification of coronary ectasia allows for more informed decision-making and consideration of alternative treatment strategies to optimize outcomes in these patients. Our study showed that patients who underwent ad-hoc PCI had significantly higher rates of major adverse cardiovascular events (MACE), all-cause mortality, recurrent angina, and target lesion revascularization. This highlights the importance of long-term follow-up and ongoing management of patients after PCI. Careful monitoring, appropriate medication management, and lifestyle modifications are essential in patients who undergo PCI, particularly those who underwent ad-hoc procedures and have higher-risk characteristics. A multidisciplinary approach involving interventional cardiologists, imaging specialists, and other healthcare providers can enhance patient care in PCI interventions. By collaboratively evaluating patient risk factors, lesion complexity, and the presence of coronary ectasia, the team can develop more tailored treatment plans that optimize procedural success and patient outcomes.

7. Limitations

Despite the valuable insights provided by our study, several limitations must be acknowledged, which may impact the interpretation and generalizability of our findings. First, the retrospective design of our study introduces inherent limitations, such as selection bias and potential confounding variables. Although we meticulously controlled for confounders during data analysis, the lack of randomization may still influence the observed outcomes. Second, as a single-center study, our findings may not be representative of the broader patient population, limiting the external validity of our results. Variations in patient demographics, healthcare practices, and procedural techniques across different centers could affect the generalizability of our findings. Collaborative multicenter studies are warranted to overcome this limitation and provide more robust evidence on the outcomes of ad-hoc versus planned percutaneous coronary intervention. Third, the reliance on electronic health records for data collection might introduce inconsistencies and inaccuracies in the documentation of certain variables. Despite efforts to ensure data integrity and quality control, missing or misclassified data could affect the validity of our results. Future studies should incorporate standardized data collection procedures to mitigate potential errors and improve the reliability of the findings. Fourth, the absence of long-term follow-up data in our study restricts our ability to assess the impact of interventions over extended periods. Long-term outcomes, such as recurrent cardiovascular events and mortality rates, are essential in evaluating the sustained benefits of ad-hoc versus planned PCI. Longitudinal studies with extended follow-up periods would be valuable in providing more comprehensive insights into the efficacy and safety of both strategies. Fifth, our study focused on patients with coronary ectasia, and therefore, our findings may not be directly applicable to patients without this specific condition. Patients with coronary ectasia often have distinct clinical characteristics and might represent a subset of the overall PCI population. Future studies should explore the outcomes of ad-hoc versus planned PCI in broader patient populations to better understand the implications of these approaches in a more diverse context. Furthermore, our study did not account for operator experience and procedural volume, both of which can significantly influence procedural outcomes. The expertise and experience of the interventional cardiologist performing the procedure may impact technical success rates and clinical outcomes. Investigating the influence of operator experience on the outcomes of ad-hoc versus planned PCI could provide valuable insights for optimizing procedural planning and patient care. Finally, while we identified coronary ectasia as a predictor of mortality, our study did not explore the underlying mechanisms linking this condition to adverse outcomes. Future research should investigate the pathophysiological basis of the association between coronary ectasia and mortality, which could lead to the development of targeted interventions for improving outcomes in these high-risk patients.

8. Conclusion

In conclusion, the study provides valuable insights into the outcomes of ad-hoc versus planned PCI in patients with coronary ectasia. Our findings emphasize the importance of pre-procedural planning and comprehensive risk assessment to optimize procedural success and patient outcomes. Patients undergoing planned PCI demonstrated higher technical success rates and lower rates of adverse cardiovascular events and mortality compared to those undergoing ad-hoc PCI. Importantly, we identified coronary ectasia as an independent predictor of mortality, underscoring the significance of recognizing this condition during PCI planning. Our study highlights the need for future research involving prospective, multicenter studies with larger patient cohorts and longer follow-up periods to validate our findings and explore additional factors influencing PCI outcomes. Ultimately, incorporating risk prediction models, advanced imaging technologies, and quality improvement initiatives into clinical practice will aid in providing optimal care for patients undergoing PCI interventions, improving long-term outcomes, and enhancing the overall management of coronary artery disease.

Ethics information

The study protocol was approved by the ethical review committee (Study ID # AIMS/23/037).

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Conflicts of interest

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References

1. Subhan S, Sami A, Akhtar W, Jan MU, Ullah A, Malik J. Association of epicardial fat volume with coronary artery ectasia and coronary artery disease. *Angiology*. 2023 Jul;74(6):563–568. https://doi.org/10.1177/00033197221124776. Epub 2022 Aug 30. PMID: 36039654.
2. Ahmad M, Mehta P, Reddivari AKR, Mungee S. Percutaneous Coronary Intervention. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Sep 30, 2023 Jan–. PMID: 32310583.
3. Sandoval Y, Tajti P, Karatasakis A, et al. Frequency and outcomes of ad hoc versus planned chronic total occlusion percutaneous coronary intervention: multicenter experience. *J Invasive Cardiol*. 2019 May;31(5):133–139. Epub 2019 Jan 15. PMID: 30643040.
4. Blankenship JC, Gigliotti OS, Feldman DN, et al, Society for Cardiovascular Angiography and Interventions. Ad hoc percutaneous coronary intervention: a consensus statement from the Society for Cardiovascular Angiography and Interventions. *Cathet Cardiovasc Interv*. 2013 Apr;81(5):748–758. https://doi.org/10.1002/ccd.24701. Epub 2012 Nov 29. PMID: 23197438.
5. Krone RJ, Shaw RE, Klein LW, Blankenship JC, Weintraub WS. American College of Cardiology - National Cardiovascular Data Registry. Ad hoc percutaneous coronary interventions in patients with stable coronary artery disease–a study of prevalence, safety, and variation in use from the American College of Cardiology National Cardiovascular Data Registry (ACC-NCDR). *Cathet Cardiovasc Interv*. 2006 Nov;68(5):696–703. https://doi.org/10.1002/ccd.20910. PMID: 17039514.
6. Feldmann K, Cami E, Safian RD. Planning percutaneous coronary interventions using computed tomography angiography and fractional flow reserve-derived from computed tomography: a state-of-the-art review. *Cathet Cardiovasc Interv*. 2019 Feb 1;93(2):298–304. https://doi.org/10.1002/ccd.27817. Epub 2018 Oct 4. PMID: 30286519.
7. Malik J, Yousaf H, Abbasi W, et al. Incidence, predictors, and outcomes of DAPT non-compliance in planned vs. ad hoc PCI in chronic coronary syndrome. *PLoS One*. 2021 Jul 16;16(7): e0254941. https://doi.org/10.1371/journal.pone.0254941. PMID: 34270595; PMCID: PMC8284673.
8. Toyota T, Morimoto T, Shiomi H, et al. CREDO-Kyoto PCI/CABG Registry Cohort-2 Investigators. Ad hoc vs. Non-ad hoc percutaneous coronary intervention strategies in patients with stable coronary artery disease. *Circ J*. 2017 Mar 24;81(4): 458–467. https://doi.org/10.1253/circj.CJ-16-0987. Epub 2017 Feb 7. PMID: 28179612.
9. Rahman Z, Paul GK, Choudhury AK. Ad-hoc percutaneous coronary intervention and staged percutaneous coronary intervention. *Mymensingh Med J*. 2011 Oct;20(4):757–765. PMID: 22081203.
10. Shah M, Gajanana D, Wheeler DS, et al. Effects of staged versus ad hoc percutaneous coronary interventions on renal function-Is there a benefit to staging? *Cardiovasc Revascularization Med*. 2017 Jul-Aug;18(5):344–348. https://doi.org/10.1016/j.carrev.2017.02.017. Epub 2017 Feb 28. PMID: 28285786.
11. Truffa MA, Alves GM, Bernardi F, et al. Does ad hoc coronary intervention reduce radiation exposure? - analysis of 568 patients. *Arq Bras Cardiol*. 2015 Nov;105(5):487–492. https://doi.org/10.5935/abc.20150110. Epub 2015 Sep 8. PMID: 26351982; PMCID: PMC4651407.
12. Galassi A, Grantham A, Kandzari D, et al. Percutaneous treatment of coronary chronic total occlusions Part 1: rationale

and outcomes. *Intervent Cardiol*. 2014 Aug;9(3):195–200. https://doi.org/10.15420/icr.2014.9.3.195. PMID: 29588802; PMCID: PMC5808625.
13. Bonzel T, Schächinger V, Dörge H. Description of a Heart Team approach to coronary revascularization and its beneficial long-term effect on clinical events after PCI. *Clin Res Cardiol*. 2016 May;105(5):388–400. https://doi.org/10.1007/s00392-015-0932-2. Epub 2015 Oct 27. PMID: 26508415.
14. Campos CM, Stanetic BM, Farooq V, et al. SYNTAX II Study Group. Risk stratification in 3-vessel coronary artery disease: applying the SYNTAX score II in the heart team discussion of the SYNTAX II trial. *Cathet Cardiovasc Interv*. 2015 Nov 15; 86(6):E229–E238. https://doi.org/10.1002/ccd.25907. Epub 2015 May 6. PMID: 25946686.
15. Castro-Dominguez YS, Wang Y, Minges KE, et al. Predicting in-hospital mortality in patients undergoing percutaneous coronary intervention. *J Am Coll Cardiol*. 2021 Jul 20;78(3): 216–229. https://doi.org/10.1016/j.jacc.2021.04.067. Epub 2021 May 3. PMID: 33957239.
16. Brener SJ. Refinements in predicting in-hospital mortality following PCI: the science and art of competing risk analysis. *J Am Coll Cardiol*. 2021 Jul 20;78(3):230–233. https://doi.org/10.1016/j.jacc.2021.05.016. PMID: 34266576.
17. Schwarz B, Abdel-Wahab M, Robinson DR, Richardt G. Predictors of mortality in patients with cardiogenic shock treated with primary percutaneous coronary intervention and intra-aortic balloon counterpulsation. *Med Klin Intensivmed Notfallmed*. 2016 Nov;111(8):715–722. https://doi.org/10.1007/s00063-015-0118-8. Epub 2015 Nov 23. PMID: 26596273.
18. Kunadian V, Qiu W, Ludman P, et al. National Institute for Cardiovascular Outcomes Research. Outcomes in patients with cardiogenic shock following percutaneous coronary intervention in the contemporary era: an analysis from the BCIS database (British Cardiovascular Intervention Society). *JACC Cardiovasc Interv*. 2014 Dec;7(12):1374–1385. https://doi.org/10.1016/j.jcin.2014.06.017. PMID: 25523531.
19. Curtis JP, Geary LL, Wang Y, et al. Development of 2 registry-based risk models suitable for characterizing hospital performance on 30-day all-cause mortality rates among patients undergoing percutaneous coronary intervention. *Circ Cardiovasc Qual Outcomes*. 2012 Sep 1;5(5):628–637. https://doi.org/10.1161/CIRCOUTCOMES.111.964569. Epub 2012 Sep 4. PMID: 22949491.
20. de Waha S, Jobs A, Eitel I, et al. Multivessel versus culprit lesion only percutaneous coronary intervention in cardiogenic shock complicating acute myocardial infarction: a systematic review and meta-analysis. *Eur Heart J Acute Cardiovasc Care*. 2018 Feb;7(1):28–37. https://doi.org/10.1177/2048872617719640. Epub 2017 Jul 13. PMID: 28703046.
21. Rojas-Milán E, León CEM, García-Rincón A, et al. Cardiovascular risk factors associated with coronary ectasia and acute myocardial infarction. *Gac Med Mex*. 2021;157(6): 604–609. https://doi.org/10.24875/GMM.M21000624. PMID: 35108253.
22. Liang S, Zhang Y, Gao X, et al. Is coronary artery ectasia a thrombotic disease? *Angiology*. 2019 Jan;70(1):62–68. https://doi.org/10.1177/0003319718782807. Epub 2018 Jun 21. PMID: 29929375.