Original Article
DOI: https://doi.org/10.70749/ijbr.v3i7.2248

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

The Role of Thrombectomy in Percutaneous Coronary Intervention for STEMI Patients

Fahd Ur Rahman[1], Tayyaba Zareen Siddiqui[2], Usman Aslam[1], Syed Yasser Javaid[1], Qamar-Uz-Zaman Bhatti[1], Zohair Aziz[1]

[1]Department of Cardiology, Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Punjab, Pakistan.
[2]Department of Radiology, Combined Military Hospital, Rawalpindi, Punjab, Pakistan.

ARTICLE INFO

Keywords: ST-segment Elevation Myocardial Infarction (STEMI), Percutaneous Coronary Intervention (PCI), Thrombectomy, Thrombus Burden, TIMI Flow, No-reflow; Coronary Reperfusion.

Correspondence to: Fahd Ur Rahman, Department of Cardiology, Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Punjab, Pakistan.
Email: fahd_234@hotmail.com

Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 19-06-2025 Revised: 08-07-2025
Accepted: 08-07-2025 Published: 15-07-2025

ABSTRACT

Background: Primary percutaneous coronary intervention (PCI) is the gold standard of ST-segment elevation myocardial infarction (STEMI). However, the presence of a heavy burden of thrombus can complicate the outcomes by inducing the possibility of distal embolization and no-reflow. Thrombectomy has been reinstated as a strategy of reperfusion enhancement, which is a controversial procedure. **Objective:** To identify the effectiveness of thrombectomy in primary PCI in STEMI patients at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan. **Methods:** The prospective observational study was conducted at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi in the duration from 15th December, 2024 to 15th June, 2025. Two hundred patients with STEMI who underwent PCI were recruited. Patients who had angiographically confirmed high thrombus load were subjected to selective thrombectomy, and the outcomes were compared across the cohort. Measured outcomes included clinical and angiographic outcomes (TIMI 3 flow, no-reflow, recurrent ischemia, heart failure, and in-hospital mortality). **Results:** The mean age of the patients was 58.4 years, with 76% of them being male. The burden of thrombus was great (64% of patients), and 22% of patients required bailout thrombectomy. TIMI 3 flow was achieved in 89 percent of the patients. No-reflow was noted in 8, in-hospital mortality was seen in 5, recurrent ischemia and heart failure in 6 and 10 cases, respectively. The selective use of thrombectomy was linked with better reperfusion and positive in-hospital outcomes. **Conclusion:** Selective thrombectomy is a helpful complement to PCI in high-thrombus-burden patients with STEMI. It enhances the performance of angiography and reduces complications, which justifies the importance of patient selection in a personal approach in the modern practice of interventional cardiology.

INTRODUCTION

STEMI is an acute ST-segment elevation myocardial infarction that is the primary cause of morbidity and mortality in all parts of the world, despite tremendous progress that has been made in cardiovascular medicine and interventional cardiology. The new standard is reperfusion therapy that incorporates primary percutaneous coronary intervention (PCI) to attempt to reinstate coronary blood flow and prevent myocardial damage (1). The enormous thrombus burden during PCI generally complicates the procedure and increases the risk of distal embolization, microvascular obstruction, and consequent no-reflow, which ultimately deteriorates patient outcomes (2). Adjunctive mechanical interventions have been studied to address such issues to relieve thrombus load, enhance myocardial perfusion, and enhance the efficacy of PCI in patients with STEMI. (3,4). Thrombectomy in STEMI management has been widely examined, with previous interest muted by conflicting outcomes of large randomized controlled trials. Some studies reported significant decreases in thrombus load, better myocardial blush grades, and reduced distal embolization with aspiration thrombectomy; however, others did not indicate a definite mortality benefit, and it became less commonly used (5,6).

However, modern studies have considered the thrombectomy, particularly in patients with an enormous thrombus burden, in which bailout or selective thrombectomy can be relevant (7,8). These insights have led to a reconsideration of the approach in current interventional practice, particularly in areas with high populations of STEMI. Recent registry data indicate inconsistencies in thrombectomy use across the regions, which are related to operator preference, patient

populations, and institutional guidelines. It has been noted that overall thrombectomy rates have decreased worldwide since the release of neutral trial results. a significant proportion of interventionalists still choose to use aspiration or mechanical thrombectomy on complex cases (where a visible thrombus, heavy clot burden, or impaired flow exists) (9,10). Anticoagulant interventions and pharmacological supplements, such as intracoronary glycoprotein IIb/IIIa inhibitors, have been incorporated into thrombectomy procedures to streamline reperfusion (11) further. Prevention of no-reflow, which is a complication with poor prognosis, is one of the critical issues in primary PCI of STEMI patients.

The total trial and subsequent angiographic studies have established that microvascular obstruction can persist, even after successful recanalization of the epicardial vessels has been achieved, thereby constraining myocardial salvage (12). Mechanical aspirations, pharmacological agents, and thrombectomy are strategies that are still under consideration to reduce no-reflow. There have also been significant developments in PCI, including stent design, pharmacotherapy, and peri-procedural care, which have contributed to improved patient outcomes (13). The detection and treatment of high thrombus burden are relevant in clinical practice. Heavy clot loads in patients predispose them to distal embolization and impaired microcirculatory reperfusion, requiring specific strategies. Practical recommendations and literature reviews highlight the use of personalized treatment, where thrombectomy, either manual or mechanical, can be an effective supplement for selected patients to increase the success of the procedure and reduce its complications (14). Current studies, including the attractive trial, continue to examine intra-thrombus thrombolysis versus aspiration thrombectomy, providing further information on the best practices for managing STEMI patients with an enormous thrombus burden (15).

Combined with thrombectomy, adjunctive treatment has also been examined to maximize clinical success. An example of this is the case of aspirational thrombectomy using intracoronary tirofiban, which has been shown to have superior angiographic and clinical outcomes compared to aspiration alone, and it is feasible that pharmacomechanical treatments works synergistically (16). In the meantime, predictors of adverse outcomes have been identified in risk factor analysis studies, including advanced age, delayed presentation, diabetes, and a larger thrombus burden, which have supported the idea of proactive management in high-risk subgroups (17). The new techniques, such as sustained mechanical thrombectomy and aspiration, have been proposed as promising solutions for patients with a significant thrombus burden. The Cheetah study demonstrated the feasibility and efficacy of sustained aspiration in achieving high reperfusion success rates, indicating that recent generations of thrombectomy devices may overcome some of the drawbacks of older manual devices (18).

These observations generate a new imperative to re-introduce thrombectomy into the interventional arsenal, particularly in cases where other means of PCI may not be as efficacious in providing the best myocardial reperfusion. Thrombectomy as a supplement to primary PCI is very relevant in Pakistan where cardiovascular disease burden continues to be high (16). Tertiary care units, including Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan, are burdened with STEMI patients who arrive to the hospital late and with a heavy thrombus load, which predisposes the environment in which thrombectomy-based interventions may be the most successful. Local and call to practice: Positive outcome of bailout thrombectomy in such groups of patients has been reported locally and a call to practice has been issued in the framework of patient presentation and experience in the institution (17). Further studies, such as regional data from Pakistani centers, helps clarify the effectiveness of thrombectomy in modern interventional cardiology and inform best practices for improving STEMI care (18).

Objective

To assess the effectiveness of thrombectomy as a complement to primary percutaneous coronary intervention in patients presenting with ST-segment elevation myocardial infarction at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan.

MATERIALS AND METHODS

Study design: Observational study

Study setting: Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, Pakistan

Duration of the study: From 15th December, 2024 to 15th June, 2025.

Inclusion Criteria

They had a known diagnosis of STEMI on electrocardiography with the onset of the condition within 12 hours and received primary PCI. The angiographic patients with a high thrombus burden whose operator chose to do either manual or mechanical thrombectomy were targeted.

Exclusion Criteria

Patients who had non-ST elevation acute coronary syndromes, those who had presented more than 12 hours after the onset of symptoms without continuing ischemia, patients who had undergone prior coronary artery bypass grafting, severe comorbidities (including advanced renal and hepatic failure), and patients who had refused consent were excluded.

Methods

Eligible patients underwent a routine clinical evaluation, baseline laboratory tests, and echocardiography before intervention. Standard techniques of coronary angiography were done either through radial access or femoral access. Manual aspiration thrombectomy or mechanical thrombectomy of the vessel was performed before stent placement in cases of high thrombus burden, as measured angiographically by the TIMI thrombus grade. The bailout thrombectomy was only allowed in those patients who had persistent thrombus after the initial balloon dilatation. All patients received standard pharmacological therapy, which included aspirin, P2Y12 inhibitors, and unfractionated heparin. The operator was

at liberty to administer glycoprotein IIb/IIIa inhibitors. Post-procedural monitoring of procedural success was done using TIMI grade 3 flow restoration, myocardial blush grade, and ST-segment elevation on electrocardiography among patients. Clinical outcome measures included in-hospital mortality, recurrent ischemia, heart failure and no-reflow. The data were input into a pre-formatted proforma and assessed by using SPSS 26.

RESULTS

In this, 200 acute patients with ST-segment elevation myocardial infarction (STEMI) who had primary percutaneous coronary intervention (PCI) at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi were enrolled. The control group mean age was 58.4 years and the majority of the cohort were men (76%). The study population had preexisting hypertension and diabetes mellitus in 42 and 36 percent, respectively. A majority of the patients (48) also reported that they had smoked and this highlighted the role of traditional cardiovascular risk factors in presenting STEMI in this category of patients.

Table 1

Baseline characteristics of patients

Variable	Value
Mean Age (years)	58.4
Male (%)	76
Hypertension (%)	42
Diabetes Mellitus (%)	36
Smokers (%)	48

Anterior STEMI (52 cases) and inferior STEMI (38 cases) cases dominated in terms of angiographic and procedural outcomes. The prevalence of thrombus burdens was found in 64 % of the patients and required selective thrombectomy. A bailout thrombectomy was necessitated in 22% of patients because of the persistence of thrombus after balloon angioplasty. To maximize thrombus resolution and achieve patency, glycoprotein IIb/IIIa inhibitors were administered to 30 percent of patients at the operator's discretion.

Table 2

Angiographic and procedural findings

Variable	Value
Anterior STEMI (%)	52
Inferior STEMI (%)	38
High Thrombus Burden (%)	64
Bailout Thrombectomy (%)	22
Use of GP IIb/IIIa Inhibitors (%)	30

The procedural success rate, defined as restoration of TIMI grade 3 flow, was achieved in 89% of patients. Nevertheless, in 8% of cases, the no-reflow phenomenon persisted, even after successful recanalization of the epicardial vessels was performed. In-hospital mortality was established in 5 percent of patients, recurrent ischemia and heart failure were reported in 6 percent and 10 percent, respectively. These results highlight the significance of adjunctive thrombectomy in enhancing procedural success and reducing adverse events in patients with an enormous thrombus burden.

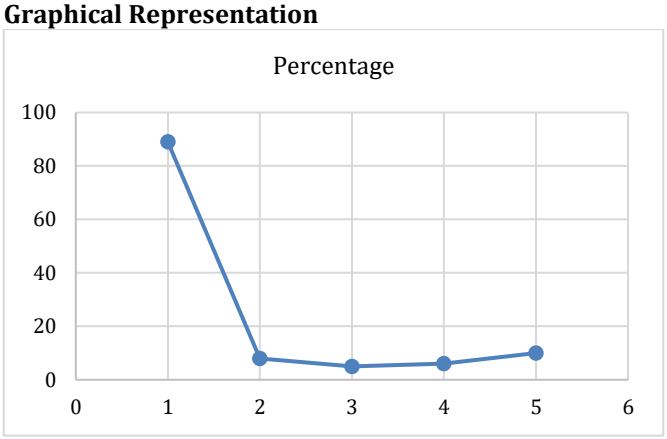
Table 3

In-hospital outcomes

Variable	Value
TIMI 3 flow achieved (%)	89
No-reflow (%)	8
In-hospital Mortality (%)	5
Recurrent Ischemia (%)	6
Heart Failure (%)	10

To illustrate the distribution of clinical outcomes, a bar graph was created, which showed the highest rates of successful reperfusion (TIMI 3 flow in 89% of patients), while adverse events such as no-reflow, recurrent ischemia, and mortality had comparatively lower rates. In general, these findings suggest that selective thrombectomy in STEMI patients reperfusion-selected during PCI at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi may positively influence reperfusion outcomes in most patients and can lead to a good in-hospital prognosis.

Graphical Representation



The figure depicts in-hospital outcomes of STEMI patients undergoing PCI and thrombectomy. Most of them had successful reperfusion, and TIMI 3 flow was observed in 89% of the cases, as reflected by the peak of the graph. There was also a reduction in complications with no-reflow 8% in-hospital mortality 5%, recurrent ischemia 6%, and heart failure 10%). The steep decline from reperfusion success to complications highlights the effectiveness of thrombectomy as an adjunct to PCI. In general, the graph indicates that, although there were some negative results, the procedure generally yielded positive in-hospital outcomes for patients.

DISCUSSION

The current paper evaluated the effectiveness of thrombectomy as an adjunct to primary percutaneous coronary intervention (PCI) in patients with ST-segment elevation myocardial infarction (STEMI) at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi. The evidence demonstrated that selective thrombectomy yielded positive procedural results, with TIMI grade 3 flow restored in the majority of patients. The frequency of no-reflow, recurrent ischemia, and in-hospital mortality was also low. These findings contribute to the expanding literature, which suggests that thrombectomy is not universally appropriate for all STEMI patients, but rather

is of value in those with a high thrombus burden or those with angiographically complicated lesions. Earlier research has shown the importance of thrombus aspiration in enhancing myocardial perfusion during primary PCI. Satti et al. reported the resurgence of thrombectomy in modern practice, indicating that the procedure is now clearly advantageous in limited situations with a heavy thrombus burden (1). Similarly, Luo et al. indicated that such deferred stenting approaches, frequently used when large thrombus is present, enhance myocardial recovery, further supporting the clinical value of thrombus management (2). After 1:1 propensity score matching to adjust for baseline differences, we found no significant differences in 30-day or 1-year all-cause mortality (HR: 1.212; 95% CI: 1.044–1.406) or stroke risk (HR: 0.865; 95% CI: 0.400–1.870) between the thrombectomy and non-thrombectomy groups. However, patients in the thrombectomy group experienced higher rates of heart failure (HF) readmissions and blood transfusion requirements at 1 year. These findings suggest that while adjunctive thrombectomy does not appear to increase the risk of mortality or stroke, its association with adverse clinical outcomes such as HF and transfusion needs indicates that its use should be reserved for carefully selected patients, particularly those with a high thrombus burden. Further prospective studies are necessary to clarify its role and determine the patient populations most likely to benefit.

These findings are consistent with our results, as patients with a high thrombus burden constituted a significant percentage of the study population, and thrombectomy helped achieve better angiographic results in this group. Comparison of pharmacological approaches and aspiration thrombectomy has been covered in several trials. In a systematic review, Kaddoura et al. demonstrated that routine thrombectomy yielded no better overall mortality benefit than intracoronary pharmacological therapy, suggesting that thrombectomy should be used selectively rather than universally (3). However, Elfekky et al. demonstrated positive results of manual aspiration in patients with a heavy thrombus load, showing decreases in distal embolization and improved myocardial perfusion (4). Similar observations were made in the current study, where selective thrombectomy gave high rates of TIMI 3 flow restoration. The observed difference and the aspect of concern in the literature is sex-based disparities of thrombus burden and outcomes. A study by Manzi et al. has found that thrombus burden is higher in male patients than in female patients, which may influence thrombectomy-related decision-making (5).

As this was a male-dominated patient population (76 percent men), the burden of thrombus and subsequent thrombectomy was greater in this study, as anticipated. Li et al. observed the interaction between thrombus aspiration and biomarkers, such as D-dimer. They noted that the benefit of thrombectomy may be greater than that of simply mechanical clot removal (6). Bin et al. also supported this observation by finding improved outcomes with aspiration thrombectomy in patients with an enormous thrombus burden (7). Rehman et al. also report positive results of bailout thrombectomy in STEMI patients in Pakistan, which, again, confirms the generalizability of selective thrombectomy to our case (8). This helps to conclude that in resource-constrained and high-volume centers such as AFIC , thrombectomy is a valuable instrument to enhance procedural outcomes, particularly in those patients having complicated coronary lesions.

Despite these advantages, there has been an overall trend toward decreasing the use of thrombectomy, especially following extensive randomized studies, such as TOTAL, which did not demonstrate a mortality benefit. These are the cutback trends highlighted by Megaly et al., but even now, many operators use thrombectomy on a selective basis (9). Inohara et al. also indicated, using the J-PCI registry, that thrombectomy remains a viable option, particularly in patients who have experienced acute coronary syndromes and angiographic evidence of heavy thrombus (10). These findings are associated with the real practice, which is comparable to our study, where thrombectomy was applied not as a routine but selectively. The other matter of importance is adjunctive pharmacological therapy. Yan et al. emphasized the importance of anticoagulation after the procedure to maximize post-PCI results, which is particularly crucial when combined with mechanical methods, such as thrombectomy (11). In addition, the no-reflow issue, which was reported in the analysis of the TOTAL trial, is a severe complication in STEMI interventions (12). In our study, no-reflow occurred in 8% of patients, which is consistent with prior studies, indicating that thrombectomy can assist but not avert this complication.

The real procedure of PCI is in a continuous evolution and stent design and adjunctive therapies are being developed to enhance results (13). Thrombectomy can still have a niche in this case as an adjunctive procedure, especially in the case of intracoronary thrombus. Feng and Liu discussed methods of treating high thrombus load, with an emphasis on an individualized approach and the application of selective thrombectomy, which is also reflected in our results (14). On the same note, the ATTRACT study is testing intra-thrombus thrombolysis versus aspiration thrombectomy, which has the potential to further enhance our understanding of the practice in this area (15). This has been observed as a potential synergy of thrombectomy and pharmacological therapy in a meta-analysis study by Marcellana et al., whereby intracoronary administration of tirofiban supplemented thrombectomy produced worse performance than thrombectomy (16). There have been reported negative outcome predictors and Yu et al. have identified the most critical risk factors to inform operator decision-making (17). These observations clearly indicate that selective patient selection is essential in thrombectomy, as was the case in our study.

Lastly, new mechanical thrombectomy devices with promising results using sustained aspiration methods have emerged recently, including the devices tested in the CHEETAH study (18). These new tools could address some shortcomings of previous manual aspiration procedures and have the potential to be incorporated into the practice of tertiary centers, such as AFIC . A combination of the results from the present research suggests the selective application of thrombectomy in STEMI patients requiring

PCI, particularly in those with an enormous thrombus burden. Although routine thrombectomy in all patients may not yield an additional mortality benefit, its targeted application to high-risk patients results in improved angiographic outcomes, better reperfusion, and fewer complications. Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi results are consistent with global evidence showing that thrombectomy is an essential adjunct of modern interventional cardiology.

CONCLUSION

This paper reveals that selective thrombectomy, performed as an adjunct to primary percutaneous coronary intervention, among STEMI patients at Armed Forces Institute of Cardiology / National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi, offers considerable procedural and clinical advantages in scenarios with abundant thrombus. TIMI grade 3 flow restoration occurred in most patients, and rates of no-reflow, in-hospital mortality, and recurrent ischemia were low. These results support the perception that, although not all patients with STEMI require routine thrombectomy, its selective application to angiographically complicated patients enhances the success of the procedure and early outcomes. The evidence from local and global research logically supports this practice, emphasizing the importance of individual patient selection and the use of adjunctive pharmacological interventions as needed. Since the thrombectomy equipment and tools are still being developed, additional studies are justified to help determine the best practices and the future of thrombectomy in modern interventional cardiology.

REFERENCES

1. Satti, Z., Omari, M., Bawamia, B., Cartlidge, T., Egred, M., Farag, M., & Alkhalil, M. (2024). The use of Thrombectomy during primary percutaneous coronary intervention: Resurrecting an old concept in contemporary practice. *Journal of Clinical Medicine*, *13*(8), 2291. https://doi.org/10.3390/jcm13082291
2. Luo, D., Hu, X., Sun, S., Wang, C., Yang, X., Ye, J., Guo, X., Xu, S., Sun, B., Dong, H., & Zhou, Y. (2021). The outcomes in STEMI patients with high thrombus burden treated by deferred versus immediate stent implantation in primary percutaneous coronary intervention: A prospective cohort study. *Annals of Translational Medicine*, *9*(7), 573-573. https://doi.org/10.21037/atm-21-1130
3. Kaddoura, R., Mohamed Ibrahim, M. I., Al-Badriyeh, D., Omar, A., Al-Kindi, F., & Arabi, A. R. (2022). Intracoronary pharmacological therapy versus aspiration thrombectomy in stemi (ipat-stemi): A systematic review and meta-analysis of randomized trials. *PLOS ONE*, *17*(5), e0263270. https://doi.org/10.1371/journal.pone.0263270
4. Elfekky, E. M., Penjameen, M. N., Nassar, A. I., & Elias, R. R. (2021). Outcome of manual thrombus aspiration for patients undergoing primary PCI for acute STEMI showing large thrombus burden. *The Egyptian Heart Journal*, *73*(1). https://doi.org/10.1186/s43044-020-00122-9
5. Manzi, M. V., Buccheri, S., Jolly, S. S., Zijlstra, F., Frøbert, O., Lagerqvist, B., Mahmoud, K. D., Džavík, V., Barbato, E., Sarno, G., & James, S. (2022). Sex-related differences in thrombus burden in STEMI patients undergoing primary percutaneous coronary intervention. *JACC: Cardiovascular Interventions*, *15*(20), 2066-2076. https://doi.org/10.1016/j.jcin.2022.08.013
6. Li, J., Lin, Z., Chen, C., Liang, S., Du, L., Qu, X., Gao, Z., Huang, Y., Kong, S., Chen, J., Sun, L., & Zhou, H. (2021). Clinical impact of thrombus aspiration and interaction with D-dimer levels in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. *Frontiers in Cardiovascular Medicine*, *8*. https://doi.org/10.3389/fcvm.2021.706979
7. Bin, N., Zhang, F., Song, X., Xie, Y., Jia, M., & Dang, Y. (2021). Thrombus aspiration during primary percutaneous coronary intervention improved outcome in patients with STEMI and a large thrombus burden. *Journal of International Medical Research*, *49*(5). https://doi.org/10.1177/03000605211012611
8. Rehman, M. U., Faisal, F., Abrar, A., Shah, A. A., Shoaib, M., & Raza, M. A. (2021). Bailout Thrombectomy: Its outcomes in patients undergoing primary percutaneous coronary intervention. *Pakistan Journal of Medical and Health Sciences*, *15*(5), 1765-1767. https://doi.org/10.53350/pjmhs211551765
9. Megaly, M., Sedhom, R., Elbadawi, A., Saad, M., Omer, M., Brilakis, E. S., Basir, M. B., Jaffer, F. A., Zaidan, M., Alqarqaz, M., & Alaswad, K. (2022). Trends and outcomes of Uilization of Thrombectomy during primary percutaneous coronary intervention. *Cardiovascular Revascularization Medicine*, *36*, 83-88. https://doi.org/10.1016/j.carrev.2021.05.021
10. Inohara, T., Kohsaka, S., Yamaji, K., Iida, O., Shinke, T., Sakakura, K., Ishii, H., Amano, T., & Ikari, Y. (2022). Use of thrombus aspiration for patients with acute coronary syndrome: Insights from the nationwide J-PCI registry. *Journal of the American Heart Association*, *11*(16). https://doi.org/10.1161/jaha.122.025728
11. Yan, Y., Gong, W., Ma, C., Wang, X., Smith, S. C., Fonarow, G. C., Morgan, L., Liu, J., Vicaut, E., Zhao, D., Montalescot, G., & Nie, S. (2022). Postprocedure anticoagulation in patients with acute ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. *JACC: Cardiovascular Interventions*, *15*(3), 251-263. https://doi.org/10.1016/j.jcin.2021.11.035
12. D'Entremont, M., Alazzoni, A., Dzavik, V., Sharma, V., Overgaard, C. B., Lemaire-Paquette, S., Lamelas, P., Cairns, J. A., Mehta, S., Natarajan, M., Sheth, T. N., Schwalm, J., Rao, S., Stankovic, G., Kedev, S., Moreno, R., Cantor, W., Lavi, S., Bertrand, O., … Jolly, S. (2023). No-reflow after primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction: An angiographic core laboratory analysis of the TOTAL trial. *EuroIntervention*, *19*(5), e394-e401. https://doi.org/10.4244/eij-d-23-00112
13. Khan, S. Q., & Ludman, P. F. (2022). Percutaneous coronary intervention. *Medicine*, *50*(7), 437-444. https://doi.org/10.1016/j.mpmed.2022.04.008
14. Feng, X., & Liu, T. (2025). Identification and management strategies for Intracoronary high thrombus burden in patients with STEMI: A practical experience and literature review. *Reviews in Cardiovascular Medicine*, *26*(7). https://doi.org/10.31083/rcm37466
15. Zhang, Z., Sheng, Z., Che, W., An, S., Sun, D., Zhai, Z., Zhao, X., Yang, Y., Meng, Z., Ye, Z., Xie, E., Li, P., Yu, C., Gao, Y., Xiao, Z., Wu, Y., Dong, F., Ren, J., & Zheng, J. (2023). Design and rationale of the attractive trial: A randomised trial of intrAThrombus thrombolysis versus aspiration

thrombeCTomy during primary percutaneous coronary intervention in ST-segment elevation myocardial infarction patients with high thrombus burden. *BMJ Open*, *13*(11), e076476. https://doi.org/10.1136/bmjopen-2023-076476

16. Marcellana, G., Jimenez, R. M., Tiongco, R. H., & Castro, R. T. (2024). Safety and efficacy of aspiration thrombectomy with intracoronary tirofiban VS aspiration thrombectomy alone in patients undergoing primary PCI: A systematic review and meta-analysis. *European Heart Journal*, *45*(Supplement_1). https://doi.org/10.1093/eurheartj/ehae666.2373
17. Yu, Y., Wu, Y., Wu, X., Wang, J., & Wang, C. (2022). Risk factors for no-reflow in patients with ST-elevation myocardial infarction who underwent percutaneous coronary intervention: A case-control study. *Cardiology Research and Practice*, *2022*, 1-7. https://doi.org/10.1155/2022/3482518
18. Mathews, S. J., Parikh, S. A., Wu, W., Metzger, D. C., Chambers, J. W., Ghali, M. G., Sumners, M. J., Kolski, B. C., Pinto, D. S., & Dohad, S. (2023). Sustained mechanical aspiration Thrombectomy for high thrombus burden coronary vessel occlusion: The multicenter cheetah study. *Circulation: Cardiovascular Interventions*, *16*(2). https://doi.org/10.1161/circinterventions.122.012433