Procedural and long-term outcomes of stent post dilatation during primary percutaneous coronary interventions

Sherif W Ayad*, Amr M Zaki, Mohamed A Sadaka and Ahmed M El Amrawy

Department of Cardiology, Faculty of Medicine, Alexandria University, Egypt

Abstract

Background: The role of stent post dilatation (SPD) during primary percutaneous intervention (PPCI) is controversial. Currently there are no clear guidelines or consensus regarding when to perform SPD and it is left to the operator decision. The aim of this study was to evaluate the procedural and long terms outcomes of SPD during PPCI.

Results: We collected retrospectively data of 614 STEMI patients who presented to Alexandria Main University hospital and International Cardiac Center (ICC) hospital, Alexandria, Egypt from January 2018 to December 2018. All patients underwent PPCI. We excluded patients with cardiogenic shock, prior CABG, severe LM disease. Patients were divided into two groups according to SPD procedure. Group 1: who had SPD included 424 patients (69.1%). Group 2: no SPD included 190 patients (30.9%). Both groups were well matched with regard to demographic data and lesion characteristics. Procedural outcomes and clinical outcomes at one year were collected. SPD patients had significantly higher incidence of no reflow during the procedure (33.7% in group 1 vs. 21.6% in group 2, P=0.026), but the final TIMI flow was similar between two groups. Also, there was no significant difference between two groups regarding other procedural outcomes as dissection, perforation, or cardiac death. After one year follow up SPD patients had significantly higher incidence of reinfarction (5.6% in group 1 vs. 1.5% in group 2, P=0.03) and significantly more target vessel revascularization (TVR) (16.7% in group 1 vs. 4.7% in group 2 P=0.001). There was no significant difference between the two groups regarding the incidence cerebrovascular stroke (CVS), heart failure or cardiac death.

Conclusion: Our study shows that SPD during PPCI is associated with an increased risk of procedural no reflow and increased risk of reinfarction as well as need for TVR after 1 year follow up. Finally, SPD did not improve clinical outcomes after 1 year follow up. Nonetheless, large-scale randomized trials are required to establish the role of SPD during PPCI.

Abbreviations: ACS: Acute Coronary Syndrome; CABG: Coronary Artery Bypass Grafting; GRACE: Global Registry of Acute Coronary Events; LCx: Left Circumflex Artery; STEMI: ST Segment Elevation Myocardial Infarction; PCI: Percutaneous Coronary Intervention; PPCI: Primary Percutaneous Coronary Intervention; TIMI: Thrombolysis In Myocardial Infarction; MACCE: Major Adverse Cardiac and Cerebrovascular Events; CVS: Cerebrovascular Stroke; RCA: Right Coronary Artery; LAD: Left Anterior Descending Artery; CAD: Coronary Artery Disease; IVUS: Intravascular Ultrasound; SPD: Stent Post Dilatation; LM: Left Main; MVD: Multivessel Disease; SVD: Single Vessel Disease; TVR: Target Vessel Revascularization; ISR: In-Stent Restenosis.

Background

Primary percutaneous coronary intervention (PPCI) is the best management for patients presenting with st-segment elevation myocardial infarction (STEMI) according to the latest guidelines [1].

The incidence of stent thrombosis is significantly higher after PPCI than after elective PCI [2]. Previous studies have shown that the most common causes of either acute or late stent thrombosis and restenosis after PPCI are malapposition and stent under expansion [3,4].

The separation of stent struts from the vessel wall seen by intravascular ultrasound (IVUS) is used to define malapposition and this interfere with the endothelialisation of the stent leading to restenosis and stent thrombosis [5,6].

Stent post-dilatation (SPD) using high pressure noncompliant balloons is used to optimize stent deployment, minimize the risk of malapposition and subsequently improve outcomes after elective PCI however this was not the same in the setting of STEMI [7-9]. SPD during PPCI increases distal embolization and leads to increased risk of no reflow [10] resulting in higher in-hospital and long term major adverse cardiac and cerebrovascular events (MACCE) [11,12].

In this study we aimed to evaluate the procedural and long-term outcomes of SPD during PPCI.

Methods

Study design

This was a retrospective observational study conducted on 614 STEMI patients who presented to Alexandria Main University hospital and International Cardiac Center (ICC), Alexandria, Egypt from first of January 2018 till end of December 2018. The Inclusion criteria were established diagnosis STEMI and candidates for PPCI [1]. While the

*Correspondence to: Sherif Wagdy Ayad, Department of Cardiology, Faculty of Medicine, Alexandria University, Egypt, E-mail: sherifwagdyayad@yahoo.com

Key words: ST segment elevation myocardial infarction, stent post dilatation, primary percutaneous intervention

Received: November 05, 2020; Accepted: November 19, 2020; Published: November 30, 2020
Exclusion criteria were previous CABG, cardiogenic shock, previous PCI of same culprit vessel and severe Left main (LM) disease. Patients were divided into two groups

**Group 1:** Included 424 STEMI patients with SPD performed during PPCI.

**Group 2:** Included 190 STEMI patients with no SPD performed during PPCI.

**Data collection**

Regarding demographic data, we registered age, gender, comorbidities (hypertension, diabetes, dyslipidemia, family history of coronary artery disease, prior ACS or PCI), and smoking.

Among in-hospital treatments, we registered PCI procedure details including culprit artery, number of diseased vessels, the use of thrombus aspiration catheter, the use of antithrombotic therapy (acetyl salicylic acid, clopidogrel, ticagrelor, heparin, enoxaparin and glycoprotein IIb/IIIa inhibitors), balloon predilatation, stents (number, length and diameter), size of balloon used in SPD and Thrombolysis in Myocardial Infarction (TIMI) flow at the end of the procedure [12]. Baseline and at hospital discharge GRACE risk score was calculated [13].

**Endpoint measurements**

The procedural outcomes were the TIMI flow in the culprit artery at the end of the procedure and the incidence of complications (No reflow, perforation, dissection, bleeding) and cardiac death while the long-term outcomes were MACCE which was defined as a composite of death, re-infarction, need for revascularization, heart failure and cerebrovascular stroke after a minimum of one year follow up.

**Statistical analysis**

Data were analyzed using the Statistical Package for Social Sciences (SPSS version 20.0, Armonk, NY: IBM Corp) [14]. We described qualitative data using number and percent and we described quantitative data using range (minimum and maximum), mean, standard deviation and median. The used tests were Chi-square test for categorical variables to compare between different groups, Fisher’s Exact or Monte Carlo correction for chi-square when more than 20% of the cells have expected count less than 5, Mann Whitney test for abnormally distributed quantitative variables, to compare between two studied groups. Values below 0.05 are considered significant for all tests.

**Results**

**Patients characteristics**

Both groups were well matched with respect to the demographic data and clinical characteristics with no significant difference between the two groups. The baseline characteristics of both groups are presented in Table 1.

**Grace risk score**

Patients in group 1 had higher grace risk score at admission than patients in group 2. This was statistically significant (P=0.017). The grace risk score of both groups is presented in Table 2.

**Procedural characteristics of the studied population**

Regarding the angiographic data, the incidence of multivessel disease was significantly higher in patients of group 2 compared to patients in group 1 (23.2% vs. 11.8% P=0.011). There was no statistically significant difference among both groups regarding the culprit artery. In group 1, 84 patients (19.8%) patients had diabetes and UK/Ii inhibitors while in group 2, 40 (21.1%) patients did. This was not statistically significant P=0.802. The use of thrombus aspiration catheter was significantly higher in patients of group 2 compared to patients in group 1 (33.7% vs. 21.7% P=0.026).

**Procedural outcome**

Group 1 patients showed higher incidence of No reflow than group 2 patients (33.7% vs. 21.6%) this was statistically significant (p=0.026), but there was no statistically significant difference among patients of both groups regarding the TIMI flow in the culprit artery at the end of the procedure. Severe bleeding, perforation and dissection did not occur in any of the patients of both groups. Cardiac death while in hospital occurred in 6 patients of group 1 (1.4%) and 4 patients in group 2 (2.1%). This was not statistically significant p=0.69. The data of procedural outcomes are summarized in Table 4.

Table 1. Baseline characteristics of the studied populations. χ²: Chi square test; p: p value for comparing between the two studied groups; *: Statistically significant at p ≤ 0.05

| Sex       | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | χ² | P  |
|-----------|-----------------|------------------|------------------|----|----|
| Male      | 528 (86%)       | 358 (84.4%)      | 170 (89.5%)      | 0.115 | 0.735 |
| Female    | 86 (14%)        | 66 (15.6%)       | 20 (10.5%)       |     |    |
| Age (years) |                   |                  |                  |     |    |
| Min. – Max. | 26.0 – 85.0     | 26.0 – 85.0      | 27.0 – 82.0     |     |    |
| Mean ± SD. | 56.80 ± 11.43   | 57.33 ± 11.99    | 55.60 ± 11.02   | 0.279 | 0.541 |
| Median    | 57.0            | 58.0             | 56.0             |     |    |
| FH or CAD | 150 (24.4%)     | 90 (21.2%)       | 60 (31.6%)      | 3.808 | 0.051 |
| Dyslipidemia | 146 (23.8%)   | 104 (24.5%)     | 42 (22.1%)      | 0.213 | 0.645 |
| HTN       | 296 (48.2%)     | 210 (49.5%)      | 86 (45.3%)      | 0.478 | 0.489 |
| DM        | 298 (48.5%)     | 218 (51.4%)      | 80 (42.1%)      | 2.276 | 0.131 |
| Smoking   | 268 (43.6%)     | 170 (40.1%)      | 98 (51.6%)      | 3.518 | 0.061 |
Long term outcomes (at least 1 year follow up)

The incidence of re-infarction and the need for target vessel revascularization (TVR) were significantly higher in patients of group 1 compared to patients in group 2. Re-infarction occurred in 24 patients (5.6%) of group 1 and 3 patients in group 2 (1.5%) \( p=0.03 \) while the need for TVR occurred in 71 patients (16.7%) in group 1 and 9 patients (4.7%) in group 2 \( p<0.001 \). There was no significant difference between the two groups regarding the incidence cerebrovascular stroke (CVS), heart failure or cardiac death. The data of 1 year follow up outcomes are summarized in Table 5.

Discussion

Proper stent deployment has been documented to predict better short- and long-term outcomes after PCI [15]. SPD during PCI provides full stent expansion and thus prevents malapposition which is the main factor responsible for stent thrombosis and restenosis in the DES era [16-20].

Table 2. Grace risk score at admission of the studied population. \( \chi^2 \): Chi square test; \( p \): p value for comparing between the two studied groups; *: Statistically significant at \( p \leq 0.05 \)

| GRACE score | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|-------------|----------------|------------------|------------------|-------------|--------|
| <140        | 262 (42.7%)    | 200 (47.2%)      | 62 (32.6%)       | 5.668*      | 0.017* |
| >140        | 352 (57.3%)    | 224 (52.8%)      | 128 (67.4%)      |             |        |

Table 3. Procedural characteristics of the studied population. \( \chi^2 \): value for Chi square; MC: Monte Carlo test; \( p \): p value for comparing between the two studied groups; *: Statistically significant at \( p \leq 0.05 \)

| MVD          | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|--------------|----------------|------------------|------------------|-------------|--------|
| ≤2.75 mm     | 126 (14.7%)    | 106 (17.6%)      | 20 (7.8%)        | 0.001*      |        |
| >2.75 mm     | 732 (85.3%)    | 496 (82.4%)      | 236 (92.2%)      | 10.65       |        |

| Culprit vessel | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|----------------|----------------|------------------|------------------|-------------|--------|
| LAD            | 342 (55.7%)    | 252 (59.4%)      | 90 (47.4%)       | 5.905       | <0.05* |
| RCA            | 194 (31.6%)    | 126 (29.7%)      | 68 (35.8%)       | 0.109       | 0.741  |
| LCX            | 78 (12.7%)     | 46 (10.8%)       | 32 (16.9%)       |             |        |

| Thrombus aspiration | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|--------------------|----------------|------------------|------------------|-------------|--------|
| GP IIb/IIIa        | 124 (20.2%)    | 84 (19.8%)       | 40 (21.1%)       | 0.063       | 0.802  |

| Pre stent dilation | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|--------------------|----------------|------------------|------------------|-------------|--------|
| ≤20mm              | 768 (82.5%)    | 478 (79.4%)      | 290 (89.8%)      | 8.28        | <0.004* |

| Stent length       | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|--------------------|----------------|------------------|------------------|-------------|--------|
| ≤20mm              | 768 (82.5%)    | 478 (79.4%)      | 290 (89.8%)      | 8.28        | <0.004* |

| Number of stents   | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|--------------------|----------------|------------------|------------------|-------------|--------|
| 1                  | 404 (65.8%)    | 272 (64.2%)      | 132 (69.5%)      | 3.005       | <0.05* |
| 2                  | 180 (29.3%)    | 130 (30.7%)      | 50 (26.3%)       | 0.109       | 0.741  |
| 3                  | 24 (3.9%)      | 18 (4.2%)        | 6 (3.2%)         | 0.063       | 0.802  |
| 4                  | 6 (1.0%)       | 4 (0.9%)         | 2 (1.0%)         | 0.063       | 0.802  |

| TIMI flow         | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|-------------------|----------------|------------------|------------------|-------------|--------|
| No reflow         | 156 (25.4%)    | 143 (33.7%)      | 41 (21.6%)       | 4.973       | 0.026* |
| Cardiac death     | 8 (1.3%)       | 6 (1.4%)         | 4 (2.1%)         | 2.987       | 0.09   |
| Perforation       | 0              | 0                | 0                |             |        |
| Dissection        | 0              | 0                | 0                |             |        |
| Severe bleeding   | 0              | 0                | 0                |             |        |

Table 4. Procedural outcomes of the studied population. \( \chi^2 \): value for Chi square; MC: Monte Carlo test; \( p \): p value for comparing between the two studied groups; *: Statistically significant at \( p \leq 0.05 \)

| TIMI flow         | Total (n = 614) | Group 1 (n = 424) | Group 2 (n = 190) | \( \chi^2 \) | \( p \) |
|-------------------|----------------|------------------|------------------|-------------|--------|
| No reflow         | 156 (25.4%)    | 143 (33.7%)      | 41 (21.6%)       | 4.973       | 0.026* |
| Cardiac death     | 8 (1.3%)       | 6 (1.4%)         | 4 (2.1%)         | 2.987       | 0.09   |
| Perforation       | 0              | 0                | 0                |             |        |
| Dissection        | 0              | 0                | 0                |             |        |
| Severe bleeding   | 0              | 0                | 0                |             |        |
Currently there are no clear guidelines or consensus regarding when to perform SPD and it is left to the operator decision. Although the appealing benefits of SPD in reducing the risk of in-stent restenosis and stent thrombosis, it has been correlated with serious adverse events as edge dissection and perforation [21,22]. Also, previous trials showed that SPD increases the risk of distal embolization and subsequently the risk of no refow phenomena after PPCI [23,24].

The rationale beyond this study was that previous trials showed contradictory results about the benefits of SPD during PCI and that previous studies excluded patients presenting with STEMI.

So, we aimed in this study to evaluate the procedural and long terms outcomes of SPD during PPCI.

In our study the incidence of no refow was significantly higher in the SPD group compared to the non SPD group (33.7% vs. 21.6%, p=0.026). Although transient impairment of TIMI flow occurred after SPD but there was no significant difference among the two groups regarding the final TIMI flow due to the use of intracoronary vasodilators. Gao P. et al. also reported higher incidence of no refow after SPD during PPCI and they speculated that the probable mechanisms of this phenomenon were stent overexpansion, fisure or dissection [25]. Also, previous study conducted by the TIMI group showed that stent overexpansion is associated with higher risk of mortality [26]. On the other hand, Karamasis G. et al. showed that SPD during PPCI did not increase the incidence of no refow [27].

The main findings in our study were that patients in group1 had significantly higher incidence of re-refow (5.6% vs. 1.5%, p=0.03) of need for TVR (16.7% vs. 4.7%, p <0.001) with no significant difference among both groups regarding cardiac death, heart failure or stroke after one year follow up.

These results are consistent with most studies addressing the impact of SPD during PPCI. They concluded that apart from higher incidence of no refow phenomena after PPCI [23,24].

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable (no individual personal data are included in the study).

Availability of data and materials: All data analyzed during this research are included in this published article.

Competing interests: All authors declare that they have no competing interests.

Funding: No external funding was acquired for this research.

Authors’ contributions: SWA, AME, and MAS contributed to conception, design, data interpretation, and supervision of the study. All authors read and approved the final manuscript.

Acknowledgements: None.

References

1. Ibanez B, James S, Agewall S, AntIluis MJ, Bucciarelli-Ducci C, et al. (2018) ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 39: 119-177. [Crossref]

2. Van der Hoeven BL, Liem SS, Dijkstra J, Bergheanu SC, Putter H, et al. (2008) Stent malapposition after sirolimus eluting and bare-metal stent implantation in patients with ST-segment elevation myocardial infarction: acute and 9-month intravascular ultrasound results of the MISSION! Intervention study. JACC Cardiovasc Interv 1: 192-201. [Crossref]

3. Sonoda S, Morino Y, Ako J, Terashima A, Hassan AHM, et al. (2004) Impact of final stent dimensions on long-term results following sirolimus-eluting stent implantation: serial intravascular ultrasound analysis from the siirus trial. J Am Coll Cardiol 43: 1959-1963. [Crossref]

4. Fitzgerald PJ, Oshima A, Hayase M, Metz JA, Bailey SR, et al. (2005) Final results of the Can Routine Ultrasound Influence Stent Expansion (CRUISE) study. Circulation 5: 523-530. [Crossref]

5. Kozuma K, Costa MA, Sabate M, Serrano P, van der Giessen WJ, et al. (1999) Late stent malapposition occurring after intracoronary beta-irradiation detected by IVUS. J Invasive Cardiol 11: 651-655. [Crossref]

6. Mintz GS, Weissman NJ, Fitzgerald PJ (2001) IVUS assessment of the mechanisms and results of brachytherapy. Circulation 104: 1320-1325. [Crossref]

7. Blackman DJ, Porto I, Shirodaria C, Channon KM, Banning AP (2004) Usefulness of high-pressure post-dilatation to optimize deployment of drug-eluting stents for the treatment of diffuse in-stent coronary restenosis. Am J Cardiol 7: 922-925. [Crossref]

8. Johansson B, Allared M, Borgencrantz B, Brorson L, Geijer HK, et al. (2002) Standardized angiographically guided overdilatation of stents using high pressure technique optimize results without increasing risks. J Invasive Cardiol 5: 221-226. [Crossref]

9. Brodie BR, Cooper C, Jones M, Fitzgerald P, Cummins F, et al. (2003) Is adjunctive balloon postdilatation necessary after coronary stent deployment? Final results from the POSTIT trial. Catheter Cardiovasc Interv 2: 184-192. [Crossref]
Ayad SW (2020) Procedural and long-term outcomes of stent post dilatation during primary percutaneous coronary interventions

10. Iijima R, Shinji H, Ikeda N, Itaya H, Makino K, et al. (2006) Comparison of coronary arterial finding by intravascular ultrasound in patients with “transient no-reflow” versus “reflow” during percutaneous coronary intervention in acute coronary syndrome. Am J Cardiol 97: 23-33. [Crossref]

11. Brodsh D, Assali AR, Mager A, Porter A, Hasdai D, et al. (2007) Effect of no-reflow during primary percutaneous coronary intervention for acute myocardial infarction on six-month mortality. Am J Cardiol 99: 442-445. [Crossref]

12. Resnic FS, Wainstein M, Lee MK, Behrendt D, Wainstein RV, et al. (2003) No-reflow is an independent predictor of death and myocardial infarction after percutaneous coronary intervention. J Am Heart J 145: 42-46. [Crossref]

13. TIMI Study Group (1989) Comparison of invasive and conservative strategies after treatment with intravenous tissue plasminogen activator in acute myocardial infarction. Results of the thrombolysis in myocardial infarction (TIMI) phase II trial. N Engl J Med 320: 618-627. [Crossref]

14. Tang EW, Wong CK, Herbison P (2007) Global Registry of Acute Coronary Events (GRACE) hospital discharge risk score accurately predicts long-term mortality post-acute coronary syndrome. Am Heart J 153: 29-35. [Crossref]

15. Kirkpatrick LA, Feeney BC. (2013) A simple guide to IBM SPSS statistics for version 20.0. Student ed. Belmont, Calif.: Wadsworth, Cengage Learning.

16. Romagnoli E, Sangiorgi GM, Cosgrave J, Guiliet E, Colombo A (2008) Drug-eluting stenting: the case for post-dilation. JACC Cardiovasc Interv 1: 22-31. [Crossref]

17. Williams PD, Mamas MA, Morgan KP, El-Omari M, Clarke B, et al. (2012) Longitudinal stent deformation: a retrospective analysis of frequency and mechanisms. Euro Intervention 8: 267-274. [Crossref]

18. de Ribamar Costa J Jr, Mintz GS, Carlier SG, Costa RA, Fujii K, et al. (2005) Intravascular ultrasonic assessment of stent diameters derived from manufacturer’s compliance charts. Am J Cardiol 96: 74-78. [Crossref]

19. Gao Z, Yang YJ, Xu B, Chen JL, Qiao SB, et al. (2008) Is adjunctive balloon postdilatation necessary with drug-eluting stents? One center experience in Chinese patients. Chin Med J 121: 513-517. [Crossref]

20. Tanabe K, Seruyus PW, Degetektin M, Grube E, Guagliumi G, et al. (2005) Incomplete stent apposition after implantation of paclitaxel-eluting stents or bare metal stents: insights from the randomized TAXUS II trial. Circulation 111: 900-905. [Crossref]

21. Kim YS, Koo BK, Seo JB, Park KW, Suh JW, et al. (2009) The incidence and predictors of postprocedural incomplete stent apposition after angiographically successful drug-eluting stent implantation. Catheter Cardiovasc Interv 74: 58-63. [Crossref]

22. Brodie BR (2006) Adjunctive balloon postdilatation after stent deployment: is it still necessary with drug-eluting stents? J Interv Cardiol 19: 43-50. [Crossref]

23. Biwas S, Soon K, Lim YL (2012) Adjunctive balloon dilatation after stent deployment: beneficial or deleterious? Int J Cardiol 157: 3-7. [Crossref]

24. Iakovou I, Mintz GS, Dangas G, Abizaid A, Mehran R, et al. (2003) Increased CK-MB release is a “trade-off” for optimal stent implantation: an intravascular ultrasound study. J Am Coll Cardiol 42: 1900-1905. [Crossref]

25. Zhang ZJ, Marroquin OC, Stone RA, Weissfeld JL, Mulukatla SR, et al. (2010) Differential effects of postdilatation after stent deployment in patients presenting with and without acute myocardial infarction. Am Heart J 160: 979-986. [Crossref]

26. Gao P, Lin W, Wang H, Du F (2018) Application of post-dilation in ST-segment elevation myocardial infarct patients undergoing primary percutaneous coronary intervention. Int J Clin Exp Med 11: 12657-12663.

27. Gibson CM, Kirtane AJ, Boundy K, Ly H, Karmpaliotis D, et al. (2005) Association of a negative residual stenosis following rescue/adjunctive percutaneous coronary intervention with impaired myocardial perfusion and adverse outcomes among ST-segment elevation myocardial infarction patients. J Am Coll Cardiol 3: 357-362. [Crossref]

28. Karamasis G, Kalogeropoulos A, Marco V, Al-Janabi F, Toor I, et al. (2018) The effects of stent post-dilation during primary percutaneous coronary intervention (PPCI) for ST-elevation myocardial infarction (STEMI): Insights from optical coherence tomography (OCT) and coronary physiology. Catheter Cardiovasc Interv 72: 1156. [Crossref]

29. Abdelshafi K, Rha SW, Park JY, Choi BG, Choi SY (2018) Impact of Post-stenting Balloon Dilatation on 5-year Clinical Outcomes in Patients with Acute Coronary Syndrome underwent Percutaneous Coronary Intervention. J Am Coll Cardiol 72: 99.

30. Feibert O, Lagerqvist B, Oliveira GN, Omerovic E, Gudnason T, et al. (2013) TASTE Trial. Thrombus aspiration during ST-segment elevation myocardial infarction. N Engl J Med 369: 1587-1597. [Crossref]

Copyright: ©2020 Ayad SW. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.