
CASE REPORT

Bailout Bifurcation strategy in Primary PCI

Muhammad Waqas Mazhar, Khawaja Ehtesham Ahmed & Omar Rafifan Alanazi

King Fahd Specialist hospital Tabuk, Kingdom of Saudi Arabia.

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Corresponding Author Email:

dr.waqas19@hotmail.com

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Abstract

Background: Primary percutaneous coronary intervention (PCI) is a critical procedure for managing acute ST elevation myocardial infarction (MI). Bifurcation lesions, in particular, pose unique challenges during PCI, necessitating specialized strategies to optimize procedural success and minimize adverse outcomes.

Case Presentation: We present a case of a 60-year-old male with a history of hypertension who presented with acute anterior ST elevation MI complicated by acute atrial fibrillation at 2 AM. Coronary angiography revealed acute proximal to mid total occlusion of the left anterior descending artery (LAD) and a large first diagonal branch. Despite encountering challenges during the procedure, including the need for bailout bifurcation stenting, successful restoration of normal sinus rhythm was achieved with electrical cardioversion.

Management & Results: The patient was discharged after 72 hours and scheduled for staged PCI to the right coronary artery. The use of the inverse culotte technique in this case highlights the importance of meticulous angiographic assessment and adaptability in managing unexpected complexities during primary PCI.

Conclusion: Follow-up revealed stable clinical outcomes, emphasizing the significance of comprehensive post-procedural care and long-term medication adherence. Additionally, discussions underscore the technical considerations and potential limitations associated with culotte stenting, particularly in cases with narrow bifurcation angles.

Keywords

Primary PCI, Bailout Bifurcation, Inverse Culotte, Follow up



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Introduction

Primary percutaneous coronary intervention (PCI) is a cornerstone in the management of acute ST elevation myocardial infarction (STEMI), aimed at restoring coronary blood flow and minimizing myocardial damage. This intervention is particularly crucial in cases of acute anterior STEMI, which often signify a significant occlusion in the left anterior descending artery (LAD), a major coronary artery supplying a substantial portion of the myocardium¹.

Acute myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide, necessitating prompt and effective management strategies. The timely initiation of reperfusion therapy, either through pharmacological means or mechanical intervention such as PCI, is crucial in salvaging ischemic myocardium and improving patient outcomes². Among the various modalities of reperfusion therapy, primary PCI has emerged as the preferred treatment option, offering superior outcomes compared to thrombolytic therapy, particularly in high-volume centers with experienced operators.

The evolution of primary PCI as the standard of care for STEMI has been driven by advancements in interventional cardiology techniques, including improvements in catheter-based technologies, antiplatelet therapies, and adjunctive pharmacotherapy. The efficacy of primary PCI in reducing mortality, reinfarction rates, and the need for urgent revascularization has been well-established in numerous clinical trials and meta-analyses, reaffirming its role as the gold standard in STEMI management³.

However, despite its proven benefits, primary PCI remains a technically demanding procedure, often complicated by various anatomical and clinical factors. Bifurcation lesions, in particular, pose unique challenges during PCI, necessitating specialized strategies to optimize procedural success and minimize adverse outcomes. Bifurcation lesions involving the LAD and its branches are not uncommon, presenting

additional complexities due to the critical role of the LAD in myocardial perfusion.

The management of bifurcation lesions in primary PCI has been a subject of considerable debate, with various techniques proposed to address the inherent challenges associated with these lesions. Culotte stenting, a two-stent bifurcation technique, has emerged as a promising strategy in cases where the bifurcation angle is < 70 degrees and there is no significant size mismatch between the main vessel and the side branch. Compared to traditional crush techniques, culotte stenting minimizes stent distortion and reduces the risk of missing parts of the lesion⁴. However, concerns regarding stent overlap and the potential for in-stent restenosis (ISR) remain, prompting operators to explore alternative approaches such as "miniculotte" techniques to mitigate these risks.

The case presented herein underscores the importance of meticulous angiographic assessment and adaptability in managing complex bifurcation lesions during primary PCI. By employing the inverse culotte technique, the operators were able to navigate the challenges posed by the narrow bifurcation angle and achieve successful revascularization while preserving coronary flow dynamics. The favorable clinical outcomes observed in this case highlight the importance of individualized treatment strategies and comprehensive post-procedural care in optimizing patient outcomes following primary PCI for acute anterior STEMI.

Case Presentation

A 60-year-old gentleman with a history of hypertension presented to the Emergency Department with complaints of acute chest pain persisting for 4 hours at 2 AM. The electrocardiogram (ECG) upon arrival revealed findings consistent with Acute anterior ST Elevation Myocardial Infarction (MI) accompanied by Acute Atrial Fibrillation, a combination that underscored the severity and urgency of the clinical presentation.

Upon assessment, the patient exhibited a TIMI Risk Score for STEMI of 8, indicative of a high-risk profile, along with KILLIP Class III classification, suggesting the presence of significant hemodynamic compromise. Two-dimensional transthoracic echocardiography (2DTTE) revealed normal left ventricular (LV) dimensions without mechanical complications, but with a reduced LV ejection fraction (LVEF) of 30%, reflecting impaired systolic function secondary to the acute myocardial infarction. Despite the compromised LV function, the patient remained hemodynamically stable at the time of presentation.

Given the high-risk nature of the clinical presentation and the presence of acute anterior ST elevation MI, urgent revascularization through primary PCI was deemed necessary. Informed consent for high-risk primary PCI was obtained, and the patient was promptly transferred to the cardiac catheterization laboratory for further evaluation and intervention.

Coronary angiography revealed significant pathology, with evidence of acute proximal to mid total occlusion of the LAD and a large 1st diagonal branch, highlighting the extensive nature of the coronary artery disease in this patient. The acute occlusion of the LAD, a critical artery supplying a substantial portion of the myocardium, necessitated immediate intervention to restore coronary blood flow and salvage ischemic myocardium.

During the course of the procedure, challenges arose, particularly concerning the management of the bifurcation lesion involving the LAD and its first diagonal branch. Despite initial attempts at conventional stenting, the complexity of the lesion required a bailed out bifurcation stenting strategy to ensure optimal results. Following meticulous wire manipulation and balloon pre-dilatation, the LAD was successfully stented using a 3*20mm stent, employing the inverse culotte technique to address the narrow bifurcation angle and optimize procedural success.

Additionally, concurrent with the PCI procedure, electrical cardioversion was performed to restore normal sinus rhythm, addressing the coexisting Acute Atrial Fibrillation and reducing the risk of further hemodynamic compromise. Post-procedural assessment revealed successful restoration of coronary flow with TIMI III flow distally, indicating adequate revascularization of the ischemic territory.

Following the completion of the primary PCI procedure, the patient was closely monitored in the cardiac care unit for 72 hours. Despite the initial complexity of the presentation and the challenges encountered during the intervention, the patient remained stable throughout the hospital course, demonstrating good tolerance to the procedure and favorable clinical progress.

Upon discharge, the patient was prescribed dual antiplatelet therapy (DAPT) and Apixaban for a duration of 3 weeks according to guidelines, followed by dual antiplatelet therapy (DAPT) for 01 year and then Aspirin only lifelong. Plans were made for staged PCI to the right coronary artery (RCA) at a later stage, ensuring comprehensive management of the underlying coronary artery disease and minimizing the risk of recurrent ischemic events.

Overall, the case underscores the importance of prompt recognition and aggressive management of acute ST elevation MI, particularly in the setting of complex coronary anatomy and concurrent arrhythmias. The successful outcome achieved in this case highlights the pivotal role of primary PCI in salvaging ischemic myocardium and optimizing patient outcomes in high-risk scenarios.

Diagnostic Assessment

Upon presentation to the Emergency Department, the patient's clinical evaluation commenced with a thorough history-taking and physical examination, focusing on the nature, onset, and characteristics of the presenting chest pain, as well as associated symptoms such as dyspnea, diaphoresis, and palpitations. Given the high index of suspicion for acute coronary syndrome, ECG was promptly

performed, revealing findings consistent with Acute anterior ST Elevation Myocardial Infarction (MI) accompanied by Acute Atrial Fibrillation.

Further diagnostic evaluation included laboratory investigations aimed at confirming the diagnosis of acute MI and assessing the patient's overall hemodynamic status. Cardiac biomarkers such as troponin levels were measured serially to detect myocardial injury and monitor for dynamic changes indicative of ongoing ischemia. Additionally, routine blood tests including complete blood count, electrolyte panel, and renal function tests were obtained to assess for any metabolic derangements and identify potential comorbidities that may impact management.

Two-dimensional transthoracic echocardiography (2DTTE) was performed to assess cardiac structure and function, providing valuable information regarding left ventricular (LV) dimensions, wall motion abnormalities, and overall myocardial performance. The presence of any mechanical complications such as ventricular septal rupture or papillary muscle dysfunction was carefully evaluated, guiding subsequent management decisions.

Coronary angiography emerged as the cornerstone of the diagnostic assessment, allowing for direct visualization of the coronary arteries and precise identification of any obstructive lesions. The angiographic findings confirmed the presence of acute proximal to mid total occlusion of the LAD and a large 1st diagonal branch, elucidating the underlying pathology driving the acute coronary syndrome presentation.

Given the complexity of the coronary anatomy and the potential need for immediate intervention, additional imaging modalities such as intravascular ultrasound (IVUS) or optical coherence tomography (OCT) may have been considered to further characterize the extent and morphology of the culprit lesion, guiding optimal stent selection and deployment.

Finally, concurrent with the diagnostic assessment, continuous cardiac monitoring and hemodynamic monitoring were instituted to monitor for any arrhythmias, hemodynamic instability, or ischemic events, allowing for timely intervention and risk stratification.

Therapeutic Intervention

The therapeutic intervention for the patient commenced promptly following the diagnostic assessment, with the goal of restoring coronary blood flow, salvaging ischemic myocardium, and addressing associated arrhythmias. Coronary angiography revealed significant pathology, including acute proximal to mid total occlusion of the LAD and a large 1st diagonal branch. After successful wiring with a BMW workhorse wire, the decision was made to stent the LAD to the diagonal branch using a 2.75*20mm stent, recognizing the LAD as the main artery. Post-stenting, balloon post-dilatation with a 3*15mm balloon was performed to optimize stent apposition and ensure adequate luminal expansion. Subsequent evaluation post-dilatation revealed the main LAD as the vessel at a narrow angle with the large first diagonal branch, resulting in the LAD becoming the jailed branch. Despite this complexity, the decision was made to proceed with a bailout bifurcation strategy to complete the intervention. The LAD was recrossed using a Pilot 50 guidewire, followed by balloon pre-dilatation to prepare the vessel for stent deployment. Bifurcation stenting was performed using a 3*20mm stent, employing the Inverse Culotte technique to address the narrow bifurcation angle and optimize procedural success. Following stent deployment, the procedure was finalized by performing proximal optimization technique (POT) 3.25*8mm NC balloon at 16 Atm followed by Kissing balloon post dilatation with 2.75*10mm balloon(D1) & 3*8mm balloon (LAD) at 12 Atm and then final POT with 3.25*8mm NC balloon at 16 ATM (POT-KISS-POT), ensuring optimal stent apposition and coronary flow restoration. Throughout the intervention, continuous monitoring of the patient's hemodynamic status and electrocardiographic rhythm was maintained to promptly address any procedural complications or arrhythmias. A total of

200ml of dye was consumed during the procedure, with acceptable fluoroscopy time. Post-intervention, electrical synchronized direct current cardioversion (DCC) was administered at 100 joules, resulting in the restoration of normal sinus rhythm. This comprehensive therapeutic approach facilitated successful revascularization and ensured favorable clinical outcomes for the patient.

Follow-up and Outcomes

Following the therapeutic intervention, the patient underwent a meticulous follow-up regimen to monitor recovery and assess long-term outcomes. The patient was discharged on dual antiplatelet therapy (DAPT) and Apixaban for 3 weeks to manage the acute coronary event and mitigate the risk of thrombotic complications. Over the subsequent months, the patient remained under close medical supervision, attending regular follow-up appointments at 6 months and 1-year post-discharge. During these visits, clinical assessments, electrocardiographic monitoring, and laboratory investigations were conducted to evaluate medication efficacy and assess for any adverse events. Staged percutaneous coronary intervention (PCI) to the right coronary artery (RCA) was successfully completed as planned, further optimizing coronary revascularization and reducing the risk of recurrent ischemic events. The patient demonstrated good compliance with the prescribed medication regimen, including DAPT and Apixaban, and reported symptomatic improvement over time. At the 1-year follow-up appointment, the patient remained stable and was doing well, with no evidence of recurrent ischemic events or procedural complications. The favorable clinical outcomes observed underscore the effectiveness of the comprehensive therapeutic approach employed in managing the complex coronary artery disease and highlight the importance of long-term follow-up and adherence to medication therapy in optimizing patient outcomes following acute myocardial infarction.

Discussion

The therapeutic intervention described in the case utilized the culotte stenting technique as a bailout strategy to address a complex bifurcation lesion

involving the LAD and its first diagonal branch. Culotte stenting is a well-established two-stent bifurcation technique that offers a valuable option for managing challenging bifurcation lesions in primary percutaneous coronary intervention (PCI). This discussion will explore the technical aspects, advantages, and potential limitations of culotte stenting, supported by relevant literature^{4,5}.

Culotte stenting is characterized by its moderate technical complexity, making it suitable for situations where the bifurcation angle is less than 70 degrees and there is minimal size mismatch between the main vessel (proximal main branch, PMB) and the side branch (SB). The technique involves the deployment of two overlapping stents, with one stent positioned in the main vessel and the other in the side branch, forming a "T" configuration. This configuration helps to minimize stent distortion compared to crush techniques and reduces the risk of missing parts of the lesion, ensuring adequate coverage of the diseased segment⁶.

Several studies have investigated the efficacy and safety of culotte stenting in the management of bifurcation lesions. For example, a study by Stankovic et al. (2006) compared culotte stenting with other bifurcation techniques and found that culotte stenting resulted in comparable procedural success rates and clinical outcomes, with lower rates of major adverse cardiac events at long-term follow-up². Similarly, a meta-analysis demonstrated that culotte stenting was associated with favorable angiographic and clinical outcomes, including lower rates of target lesion revascularization and stent thrombosis, compared to other bifurcation techniques^{7,8}.

Despite its advantages, culotte stenting does have limitations that warrant consideration. One potential drawback is the commitment of the patient to two layers of stent in the proximal main branch (PMB), which may increase the risk of in-stent restenosis (ISR) due to neointimal hyperplasia. Additionally, the technique may require meticulous stent positioning and sizing to minimize overlap and optimize stent apposition,

which can be challenging in cases of complex bifurcation anatomy.

To address these limitations, some operators have explored modifications of the culotte technique, such as "mini-culotte" techniques, aimed at reducing the amount of overlap between the stents while still achieving adequate lesion coverage. These modifications aim to mitigate the risk of ISR associated with excessive stent overlap while maintaining the benefits of culotte stenting in terms of stent distortion and lesion coverage.

Conclusion

In conclusion, culotte stenting emerges as a valuable strategy for addressing intricate bifurcation lesions during primary PCI, offering notable benefits including reduced stent distortion and comprehensive lesion coverage. Despite its advantages, this technique entails a moderate level of technical complexity and carries the potential for increased risk of in-stent restenosis (ISR). However, innovative adaptations such as "mini-culotte" techniques hold promise in optimizing procedural outcomes. Continued research and clinical experience are imperative to refine the application of culotte stenting and devise strategies to enhance its safety and efficacy in clinical practice. Additionally, the importance of meticulous angiographic assessment before primary PCI cannot be overstated, emphasizing the need for careful scrutiny and adaptability in response to unexpected findings. In cases involving narrow angled bifurcation lesions < 70 degrees, the use of the Inverse Culotte technique emerges as a viable strategy for achieving favorable outcomes.

Learning points

Recognition of High-Risk Presentation: The case underscores the importance of promptly recognizing high-risk presentations of acute myocardial infarction, particularly in patients presenting with acute anterior ST elevation MI accompanied by acute atrial fibrillation. This highlights the need for a comprehensive approach to assessment and risk stratification in the emergency setting.

Importance of Coronary Angiography:

Coronary angiography remains the gold standard for diagnosing and characterizing coronary artery disease, allowing for precise identification of culprit lesions and guiding therapeutic decision-making. The angiographic findings in this case facilitated the selection of appropriate interventional strategies to address complex coronary anatomy.

Adaptability in Interventional Techniques: The case demonstrates the need for adaptability in interventional techniques, particularly in the management of complex bifurcation lesions. The decision to employ a bailout bifurcation strategy using culotte stenting highlights the importance of procedural flexibility and the ability to adjust techniques based on anatomical and procedural complexities.

Utilization of Advanced Interventional Tools:

The successful management of complex bifurcation lesions necessitates the utilization of advanced interventional tools and techniques, such as specialized wires, balloons, and stents. In this case, the use of dedicated wires and balloons facilitated successful lesion crossing, pre-dilatation, and stent deployment, optimizing procedural outcomes.

Comprehensive Post-Procedural Care: Effective post-procedural care plays a crucial role in optimizing patient outcomes following primary PCI. The case emphasizes the importance of close monitoring, medication adherence, and structured follow-up to ensure patient stability, prevent recurrent ischemic events, and address potential complications.

Clinical Decision-Making and Patient Selection:

The case highlights the complexity of clinical decision-making in primary PCI, particularly in determining the appropriate intervention strategy based on patient characteristics, lesion morphology, and procedural challenges. This underscores the importance of multidisciplinary collaboration and individualized patient care.

Continuous Quality Improvement: The case underscores the need for continuous quality improvement in interventional cardiology practice. Reflecting on procedural outcomes, identifying areas for improvement, and implementing strategies to enhance procedural success and patient safety are essential for advancing clinical practice and optimizing patient care.

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Figure/Video

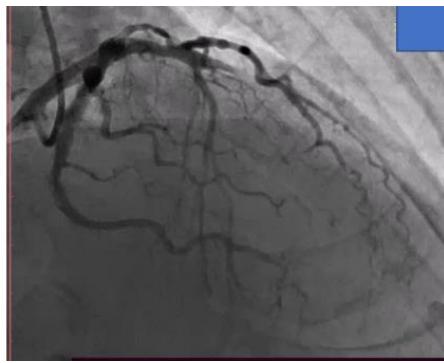


Figure 1: Total occlusion of mid LAD



Figure 2: Retrograde cross-filing of LAD & D1

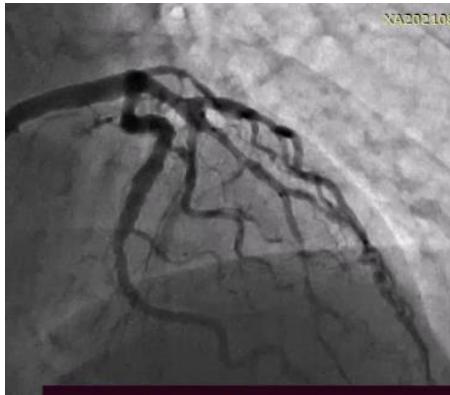


Figure 3: Initial wiring with Sion blue guidewire and balloon pre dilatation



Figure 4: stented the LAD to diagonal. Now LAD jailed mistakenly.



Figure 5: LAD re-crossed with Pilot 50 GW. Narrow angle between the LAD & Diagonal

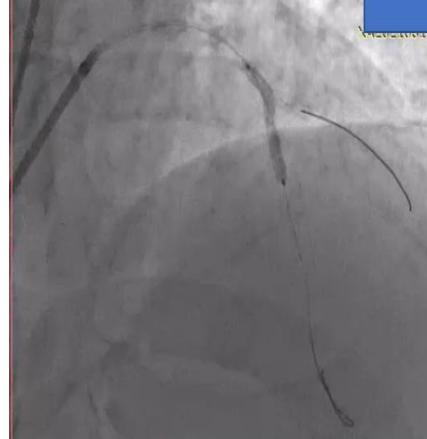
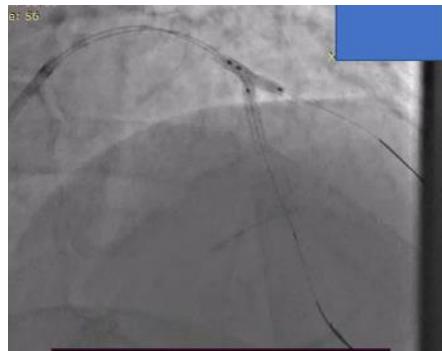


Figure 6: stented the LAD. after recrossing and ballooning the previously deployed stent (Inverse Culotte)



**Figure 7 (A&B): Final KBPD
LAD-Diagonal 2.75*10, LAD 3*8mm Balloon
Final POT 3.25*8mm Balloon**

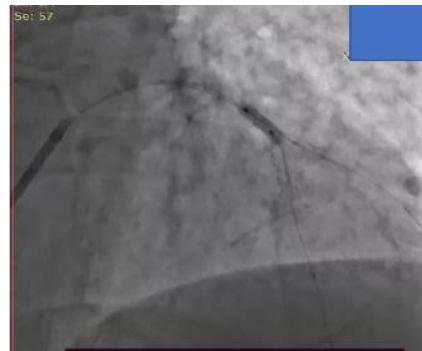




Figure 8: Result (Inverse Culotte during Primary PCI)