

CASE REPORT

Mini Crush with Rota Ablation

Saleha Haroon

Rawalpindi Institute of Cardiology Rawalpindi - Pakistan

Abstract

Background: Coronary artery disease (CAD) remains a significant cause of morbidity and mortality worldwide, particularly in elderly individuals. Complex coronary lesions, such as bifurcation disease with calcific plaques, further exacerbate the treatment dilemma, necessitating innovative approaches to revascularization.

Case Presentation: An 85-year-old frail male, normotensive and normoglycemic, presented with non-ST segment elevation myocardial infarction (NSTEMI). Angiogram revealed triple vessel disease, with particularly critical involvement of the distal left main stem (LMS) and complex bifurcation disease in the proximal left anterior descending artery LAD and ostioproximal course of Ramus intermedius. Despite referral for coronary artery bypass grafting (CABG), surgical intervention was deemed unsuitable due to the patient's advanced age and frailty.

Management & Results: The patient underwent mini crush bifurcation stenting from LMS to LAD and Ramus intermedius, preceded by rota ablation of the calcific LAD lesion. The final outcome, assessed by intravascular ultrasound (IVUS) imaging, demonstrated optimal results.

Conclusion: In elderly, frail patients with triple vessel coronary artery disease (TVCAD) who are unsuitable candidates for surgery, complex bifurcation stenting can be a viable option. However, meticulous lesion preparation and IVUS-guided revascularization are crucial, especially in cases involving left main stem bifurcation stenting, to improve procedural outcomes.

Keywords

Complex bifurcation stenting, Rota ablation, Calcific left anterior descending artery (LAD), Ramus intermedius, Intravascular imaging

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Corresponding Author Email:

drsalehatarar@hotmail.com

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Introduction

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality globally, with coronary bifurcation lesions representing up to 20% of all stenosis cases¹. These lesions present unique challenges due to their anatomical complexity, often requiring intricate management strategies to achieve optimal outcomes.

In the realm of complex bifurcation disease, the upfront strategy utilizing the double-kissing (DK) crush technique has gained prominence. This technique involves the sequential deployment of two stents in both the main branch and the side branch, followed by balloon kissing inflation to optimize stent apposition and expansion². However, a drawback of the DK crush technique is the potential for a 4-5 mm protrusion of the side branch stent, leading to a significant volume of crushed stent material within the bifurcation area. This excessive stent volume can predispose to restenosis and thrombosis, thereby compromising long-term outcomes³.

To address this concern, modifications to the DK crush technique have been proposed. One such modification is the mini-crush technique, which aims to limit the protrusion of the side branch stent to approximately 2 mm into the main branch⁴. By reducing the volume of crushed stent material, the mini-crush technique seeks to minimize the risk of adverse events while maintaining the benefits of optimal stent deployment and lesion coverage.

Despite the theoretical advantages of the mini-crush technique, its clinical efficacy and safety in challenging scenarios, such as calcific bifurcation lesions, remain relatively underexplored. Moreover, its application in elderly and frail patients with triple vessel coronary artery disease (TVCAD) presents additional considerations, given the increased vulnerability of this patient population to procedural complications and adverse outcomes.

Therefore, this case report aims to shed light on the management of complex bifurcation disease in a frail elderly patient with TVCAD through the utilization of the mini-crush technique. By

presenting a detailed account of the procedural approach, including rota ablation of calcific lesions and intravascular imaging guidance, this report seeks to contribute to the existing literature on innovative revascularization strategies in high-risk patient subsets.

Case Presentation

An 85-year-old male, normotensive and normoglycemic, presented with recurrent episodes of unstable angina despite receiving optimal medical treatment. His medical history was notable for hypertension, dyslipidemia, and type 2 diabetes mellitus, which were well-controlled with antihypertensive medications, statins, and oral hypoglycemic agents, respectively. Despite adherence to medical therapy, the patient experienced worsening symptoms of chest discomfort, prompting further evaluation.

Upon admission, the patient underwent thorough clinical assessment, including electrocardiography and cardiac biomarker testing, which revealed evidence of ongoing myocardial ischemia consistent with non-ST segment elevation myocardial infarction (NSTEMI). Subsequent coronary angiography demonstrated extensive coronary artery disease, characterized by triple vessel involvement and critical lesions in the distal left main stem (LMS) and complex bifurcation disease in the proximal left anterior descending artery (LAD) and ostioproximal course of Ramus intermedius.

Given the severity and complexity of the coronary lesions, the patient was initially considered for coronary artery bypass grafting (CABG). However, surgical intervention was ultimately deemed unsuitable due to the patient's advanced age, frailty, and associated comorbidities. In light of these factors, a less invasive approach to revascularization was pursued, with a focus on percutaneous coronary intervention (PCI) utilizing innovative techniques tailored to the patient's clinical profile.

After extensive discussion with the patient and his family regarding the risks and benefits of PCI, a

decision was made to proceed with the intervention. The procedure was performed under local anesthesia and conscious sedation, with close hemodynamic monitoring throughout. Intravascular imaging modalities, including intravascular ultrasound (IVUS) and optical coherence tomography (OCT), were employed to assess lesion characteristics and guide optimal stent placement.

The PCI procedure commenced with pre-dilation of the target lesions using appropriately sized balloon catheters, followed by rotational atherectomy (rota ablation) of the calcific plaque burden in the proximal LAD. This step was crucial for lesion preparation, facilitating optimal stent expansion and apposition in the subsequent bifurcation stenting phase. Subsequently, the mini-crush bifurcation stenting technique was employed, involving the sequential deployment of stents in the LMS to LAD and Ramus intermedius, with careful attention to minimizing protrusion into the main branch.

Post-stenting, intravascular imaging was repeated to confirm adequate stent expansion and apposition, with particular emphasis on assessing the side branch ostium and the presence of any residual dissections or malapposition. The final angiographic and IVUS/OCT images demonstrated successful revascularization with optimal stent positioning and minimal residual disease burden.

Following the procedure, the patient was monitored closely in the cardiac care unit, with regular assessments of cardiac biomarkers, electrocardiography, and hemodynamic parameters. He demonstrated an uneventful recovery, with resolution of anginal symptoms and no evidence of procedural complications. He was subsequently discharged home with appropriate secondary prevention measures and scheduled for close follow-up in the outpatient cardiology clinic.

Diagnostic Assessment

Upon presentation, the patient underwent a comprehensive diagnostic assessment to evaluate the extent and severity of his CAD, as well as to

assess cardiac function and viability. The diagnostic workup included electrocardiography (ECG), echocardiography (ECHO), and coronary angiography.

The patient's ECG revealed 2mm ST segment depressions in anterior chest leads, indicative of ongoing myocardial ischemia in the territory supplied by the LAD. ST segment depressions on ECG are consistent with ischemic changes and are often seen in patients with acute coronary syndromes, such as non-ST segment elevation myocardial infarction (NSTEMI).

Echocardiography demonstrated apical, anterior, and mid to distal septal hypokinesia, indicating regional wall motion abnormalities in these segments. The patient's ejection fraction (EF) was measured at 30%, indicating significant left ventricular dysfunction. Despite the impaired contractility, the wall thickness in the affected segments was preserved, suggesting chronic ischemic insult rather than acute myocardial infarction with wall thinning.

Coronary angiography revealed critical disease in the distal course of the LMS, involving the origin of the LAD and Ramus intermedius. Additionally, there was diffuse critical disease extending from the ostium to the mid-course of the LAD, indicating significant luminal narrowing throughout this vessel. Critical disease was also noted in the ostium of the Ramus intermedius, further complicating the bifurcation lesion. Furthermore, there was diffuse critical disease in the ostioproximal course of the right coronary artery (RCA), suggesting multivessel involvement of CAD.

Therapeutic Intervention

After being deemed unsuitable for CABG due to advanced age and frailty, the patient was discussed in a heart team meeting where the decision was made to pursue percutaneous coronary intervention (PCI) as an alternative revascularization strategy. Prior to the procedure, the patient received preloading with loprin 75mg and Ticagrelor 180 mg to optimize antiplatelet therapy. The intervention was performed via right

femoral access using a 7F EBU 3.5 guide catheter, with administration of heparin 7500U to prevent thrombotic complications. Given the diffuse calcific nature of the LAD lesion, crossing was achieved with a BMW guidewire, which was subsequently exchanged for a Rota Floppy wire with support from a Teleport microcatheter to facilitate rotational atherectomy (rotaablation) using a 1.75 Rota burr.

A 3×38 mm Promus Premier stent was deployed in the mid LAD at 14 atm, followed by placement of a Choice floppy wire in the Ramus intermedius branch. The Ramus lesion was dilated using a 1.55×10 mm Sprinter balloon, and a 3×24 mm Promus Premier stent was deployed in the Ramus with 1-2mm protrusion into the main vessel. Subsequently, a 4×28 mm Promus Premier stent was deployed from the LMS to the LAD, effectively jailing the side branch wire. Post-dilation of the LMS to LAD stent was performed using a 5 ×12 NC Euphora balloon, ensuring optimal stent expansion and apposition. The Ramus branch was then rewired with a BMW wire through the proximal stent struts, followed by kissing balloon inflation using a 3×25 mm NC balloon in the Ramus and a 3.5×20 mm balloon in the LAD. Finally, post-dilation of the LMS stent was performed with a 5×12 NC Euphora balloon. Intravascular ultrasound (IVUS) imaging confirmed excellent stent apposition with no evidence of edge dissection or malapposition.

Subsequently, the patient underwent staged PCI to the right coronary artery (RCA) to address the diffuse critical disease noted in the ostioproximal course. Overall, the therapeutic intervention involved a meticulous stepwise approach, incorporating advanced techniques such as rotational atherectomy and intravascular imaging guidance to optimize stent deployment and ensure successful revascularization of the complex coronary lesions.

Follow-up and Outcomes

During the two-year follow-up period, the patient has remained asymptomatic, demonstrating excellent compliance with medical therapy and

exhibiting good functional capacity. Regular clinical assessments and monitoring have been conducted to evaluate his cardiac status and response to treatment. Notably, follow-up echocardiography performed at 2 months post-procedure revealed a significant improvement in left ventricular function, with the ejection fraction (EF) increasing from 30% to 50%. This improvement in EF reflects the successful revascularization of the ischemic myocardium, resulting in enhanced cardiac performance and overall myocardial function. The resolution of symptoms and improvement in cardiac function are indicative of a favorable long-term outcome following the percutaneous intervention, highlighting the effectiveness of the tailored revascularization strategy in alleviating ischemic burden and optimizing cardiac function in this high-risk patient population.

In addition to the cardiac parameters, the patient's clinical stability and quality of life have also been closely monitored during follow-up visits. His freedom from anginal symptoms and absence of adverse cardiovascular events further underscore the success of the intervention and the durability of the revascularization achieved. The sustained improvement in symptoms and functional status has not only enhanced the patient's overall well-being but also mitigated the need for recurrent hospitalizations or invasive interventions, thereby minimizing healthcare resource utilization and optimizing cost-effectiveness. Furthermore, the patient's adherence to secondary prevention measures, including lifestyle modifications and pharmacological therapy, has played a pivotal role in maintaining his cardiovascular health and preventing disease progression. Overall, the favorable clinical course observed during the two-year follow-up period underscores the efficacy and durability of the percutaneous revascularization strategy in achieving sustained symptomatic relief and functional improvement in this elderly, frail patient with complex coronary artery disease.

Discussion

The mini crush technique and intravascular ultrasound (IVUS)-guided stent optimization represent significant advancements in the

management of complex bifurcation lesions, offering improved procedural success rates and enhanced long-term outcomes. The mini crush technique, with its minimal protrusion of the side branch stent into the main branch and controlled balloon crush, reduces the risk of stent distortion and malapposition at the side branch ostium, potentially enhancing procedural success and minimizing adverse events. Additionally, IVUS allows for real-time visualization of vessel morphology and stent apposition, enabling operators to identify and address potential issues such as incomplete stent expansion, malapposition, and edge dissections. Literature supports the use of IVUS-guided bifurcation stenting in improving both short and long-term outcomes, with reduced rates of stent thrombosis, target lesion revascularization, and major adverse cardiac events compared to angiography-guided procedures¹.

In the presented case, the decision to pursue percutaneous coronary intervention (PCI) using the mini crush technique was made after careful consideration of the patient's advanced age and frailty, highlighting the importance of individualized treatment approaches in elderly and high-risk patients with complex CAD. The successful implementation of the mini crush technique in this case underscores its efficacy in achieving optimal stent deployment and lesion coverage in complex bifurcation lesions, leading to favorable short-term and long-term outcomes. By alleviating myocardial ischemia and optimizing cardiac function, PCI with the mini crush technique has led to significant clinical improvement and enhanced quality of life in this elderly and frail patient population. These findings underscore the importance of tailored treatment approaches and multidisciplinary care in optimizing outcomes in complex CAD patients².

Furthermore, the successful revascularization achieved in this case has implications beyond symptom relief, as it may also translate into improved long-term survival and reduced healthcare resource utilization. By mitigating the need for recurrent hospitalizations and invasive

interventions, PCI with the mini crush technique offers potential cost savings and healthcare system benefits, further supporting its role as a viable therapeutic option in select patients with complex CAD. Overall, the case highlights the importance of a comprehensive and individualized approach to the management of complex CAD in elderly and high-risk patients, with the mini crush technique and IVUS-guided stent optimization playing key roles in achieving optimal outcomes³. Further research and clinical experience are warranted to validate these findings and refine treatment strategies for optimal outcomes in complex CAD patients.

Conclusion

In conclusion, for frail, elderly patients with TVCAD deemed unsuitable for CABG and presenting with complex bifurcation lesions, the mini crush technique offers a viable treatment option. Meticulous lesion preparation, exemplified by rotational atherectomy (rota ablation) in this case, is essential for procedural success. Integration of intravascular ultrasound (IVUS) guidance ensures optimal stent sizing and deployment, particularly crucial in left main stem bifurcation stenting. Tailoring treatment to individual patient characteristics is paramount for optimizing outcomes, highlighting the importance of personalized care and multidisciplinary collaboration. Further research is needed to refine techniques and advance treatment strategies for this challenging patient population. Ultimately, innovative approaches like the mini crush technique and IVUS-guided revascularization hold promise for improving outcomes and enhancing quality of life in elderly and high-risk patients with complex coronary artery disease.

Learning points

Sizing of Side Branch Stent: In mini crush bifurcation stenting, it's crucial to size the side branch stent at a 1:1 ratio with the distal side branch diameter. Additionally, ensuring a 1-2mm protrusion into the main vessel helps in providing adequate coverage of the side branch ostium while minimizing stent distortion and malapposition. This step is essential for maintaining optimal blood flow

to the side branch and preventing complications such as side branch occlusion.

Sizing of Main Vessel Stent: The main vessel stent should be sized according to the distal main vessel diameter. Moreover, allowing for sufficient length in the proximal main vessel ensures adequate support for post-dilation optimization balloon inflation. Proper sizing of the main vessel stent is critical for achieving optimal stent expansion and apposition, thereby reducing the risk of restenosis and thrombosis.

Post-Dilation Optimization (POT) Balloon Sizing: The POT balloon should be sized at a 1:1 ratio with the proximal main vessel diameter. This ensures uniform expansion of the stent and proper apposition to the vessel wall, enhancing the long-term efficacy of the intervention. Adequate POT balloon sizing plays a pivotal role in optimizing stent deployment and minimizing the risk of adverse events such as stent malapposition or edge dissection.

Rewiring of Side Branch: When rewiring the side branch after main vessel stent deployment, care should be taken to navigate the wire through a nondistal strut. This approach minimizes disruption of the stent architecture and reduces the risk of complications such as wire entrapment or stent

deformation. Proper wire placement ensures continued patency of the side branch and facilitates subsequent interventions if necessary.

Final Kissing Balloon Inflation (KBI): In the mini crush technique, final KBI is performed once using balloons sized at a 1:1 ratio with the distal main vessel and side branch diameters. This step is crucial for optimizing stent expansion and apposition in both branches, ensuring complete coverage and reducing the risk of stent thrombosis or restenosis. Properly executed KBI helps to achieve optimal procedural outcomes and enhance long-term stent patency.

References

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- 3) Malaiapan Y, Leung M, White AJ. The role of intravascular ultrasound in percutaneous coronary intervention of complex coronary lesions. *Cardiovasc Diagn Ther.* 2020;10(5):1371–88.

Figure/Video



Figure 1: baseline angiogram (RAO cranial view)



Figure 2: Baseline angiogram (RAO caudal view)

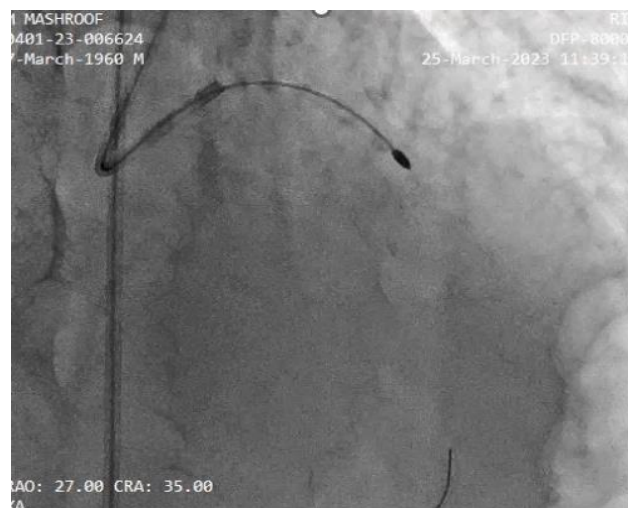


Figure 3: Rota ablation to LAD

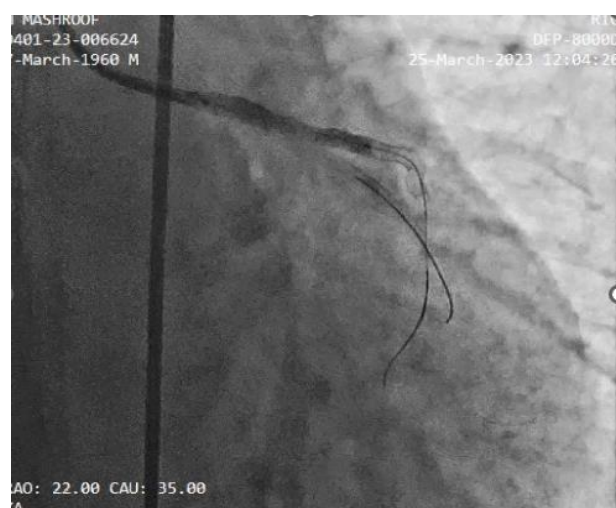


Figure 4: Minicrush performed by stent placed in main vessel

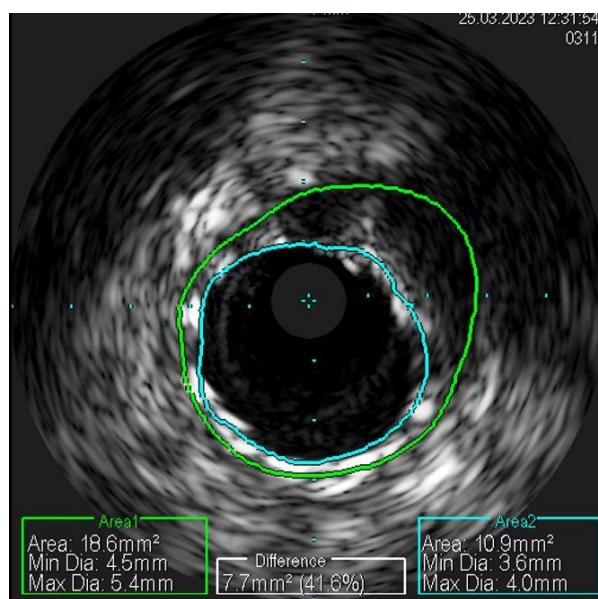


Figure 5: IVUS imaging showing well apposed stent

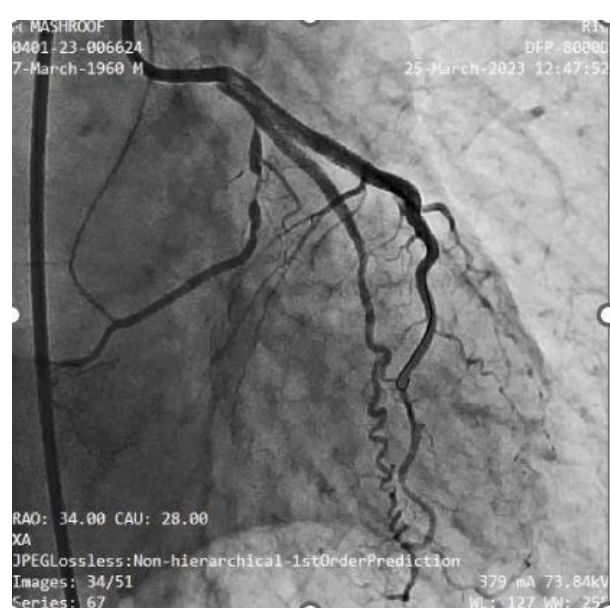


Figure 6: Final result of minicrush bifurcation stenting