The value of intravascular ultrasound in patients with acute myocardial infarction

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Abstract
Defining the best percutaneous coronary intervention (PCI) in acute myocardial infarction is sometimes difficult, bearing in mind that time is of the essence in preventing myocardial tissue damage. There are invasive modalities to determine the best strategy. These include intravascular ultrasound (IVUS) and optical coherence tomography (OCT), methods that could underline plaque rupture, thrombus, positive remodeling, greater plaque burden, and tissue prolapse. Virtual histology IVUS is capable of detecting lesions containing large necrotic cores and thin cap fibroatheroma (independent predictors of no-reflow in acute myocardial patients). Using these imagistic modalities can lead the PCI strategy in order to obtain the best possible outcome of the procedure for the patient.

Keywords
percutaneous coronary intervention, intravascular ultrasound, aspiration thrombectomy

Rezumat
Alegerea celei mai bune strategii de angioplastie coronariană în cadrul unui sindrom coronarian acut este dificilă având în vedere că timpul petrecut până la revascularizare se traduce in țesut miocardic mort. Există investigații invazive ce se utilizează pentru a alege cea mai bună strategie în infarctul miocardic acut, cum ar fi ecografia intravasculară (IVUS) și tomografia în coerență optică (OCT), metode ce pot evidenția ruptura plăcii de aterom, prezența trombilor intra arteriali, remodelarea pozitivă, prezența infiltrării severe cu calciu și prolabarea țesuturilor. Histologia virtuală - IVUS este capabilă să obiectiveze leziuni cu necroză centrală și leziuni cu capișon fibros subțire (predictori independenți ai fenomenului de no-reflow post revascularizare la pacienții cu infarct miocardic acut). Utilizarea metodelor imagistice poate să ghideze strategia de revascularizare coronariană pentru a obține cel mai bun rezultat al procedurii și implicit pentru pacient.

Cuvinte cheie
asngioplastie coronariană, ecografie intravasculară, trombo-aspirație

Introduction

Choosing the best percutaneous coronary intervention (PCI) strategy in patients with acute myocardial infarction based only on angiographic characteristics is difficult, since the mechanism can differ between cases (spontaneous plaque rupture or erosion and subsequent thrombosis) [1]. There are invasive modalities to determine the best strategy, and these include intravascular ultrasound (IVUS) and optical coherence tomography (OCT), methods that could underline plaque rupture, thrombus, positive remodeling, greater plaque burden, and tissue prolapse. Virtual histology, done by IVUS, is capable of detecting lesions containing large necrotic cores and thin cap fibroatheroma (independent predictors of no-reflow in acute myocardial infarction). IVUS has a crucial role in depicting plaque characteristics, periprocedural complications, and plaque evolution. These imagistic modalities can lead the PCI strategy in order to obtain the best possible outcome of the procedure for the patient.

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Case Report

We report the case of a 58-year-old male patient admitted to our clinic with ST-segment elevation myocardial infarction (STEMI) at 4 hours after pain onset, that had received thrombolytic therapy with reteplase 10U bolus followed by another 10U bolus after 30 minutes at 2 hours after pain onset without reperfusion criteria. The past medical history of the patient was unremarkable. His cardiovascular risk factors were stage I hypertension, dyslipidemia, smoking, and male sex.

Clinical examination at the emergency room revealed a normal blood pressure without any therapy and no other abnormal clinical signs. The electrocardiogram revealed a third-degree atrio-ventricular (AV) block with negative T waves in the inferior leads and ST segment elevation in posterior leads. Transthoracic echocardiography showed a mild reduced left ventricular ejection fraction of 45%, hypokinesis of the inferior wall, and mild to moderate mitral regurgitation.

Because we were dealing with a posterior STEMI in the first 4 hours from pain onset, we proceeded to invasive evaluation. Coronary angiogram showed a left coronary artery without any notable lesions (figure 1 and 2), but we found a massive thrombus in the right coronary artery that extended from the second segment of RCA to the distal part of both posterolateral artery (PLA) and posterior descending artery (PDA) (figure 3). Because of a high thrombus burden, we decided to perform aspiration thrombectomy.



Figure 1 - Coronary angiogram – left coronary artery (cranial projection): discrete atheromatous plaques on both left anterior descending and circumflex artery.

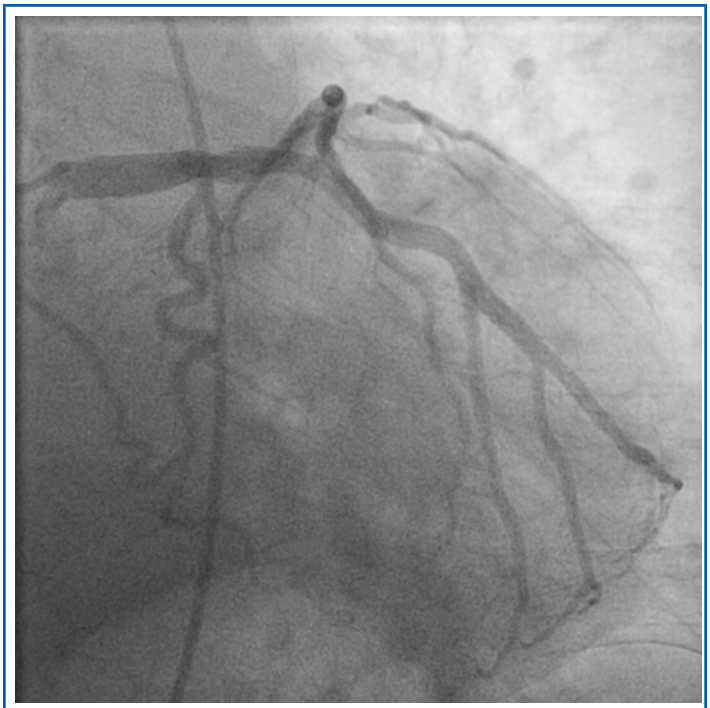


Figure 2 - Coronary angiogram – left coronary artery (caudal projection): discrete atheromatous plaque on distal left main artery.

Since both PDA and PLA were important vessels, we engaged the RCA with a 7.0 French Judkins Right guiding catheter. We used a 7.0 French guiding catheter to be able to pass simultaneously two guidewires and an aspiration thrombectomy catheter.



Figure 3. Coronary angiogram – right coronary artery (RCA): large thrombus in the mid segment of the RCA extending to posterior descending artery and posterolateral artery.

Since the thrombus extended into both PLA and PDA, we made multiple passages to both vessels, obtaining a TIMI III flow with a small amount of residual thrombus (figure 4,5).

Because after the aspiration thrombectomy we hadn't revealed any important stenosis in the RCA, we decided to perform IVUS to assess the lumen of the vessel, searching for the culprit lesion. IVUS depicted important plaque burden in the second segment of the RCA, an ulcerated plaque, best assessed by ChromaFlo recording without dissection or significant stenosis (figure 6,7,8,9). Minimal lumen area was more than 4 mm^2 along the entire RCA [2]. Some residual, mobile thrombus was still present in mid RCA, which we decided to treat with intravenous anticoagulants.

The recovery of the patient was good and the AV block was resolved. He was discharged without symptoms and with an improved left ventricular ejection fraction.

Discussions

In a patient with right dominant system, RCA is a rather big artery that is supplying more than just the right ventricle and right atrium, since the posterior descending artery emerges from it. As a consequence, we've seen the transitory third-degree AV block resolved after obtaining an optimal blood flow in the RCA. Thrombectomy catheters, while unwieldly, aids thrombus aspiration. Manual aspiration thrombectomy has been studied in large randomized controlled trials and arisen as the preferred method of thrombectomy due to its ease of use. Infarct size was found to be



Figure 4 - Coronary angiogram – right coronary artery (RCA): two hydrophilic guidewires in the posterolateral artery and posterior descending artery during aspiration thrombectomy.

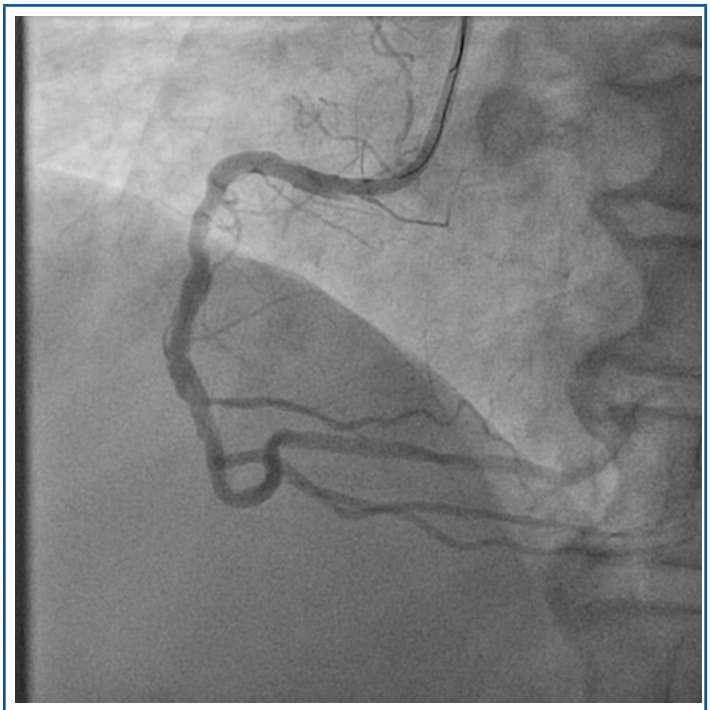


Figure 5 - Coronary angiogram – Result after aspiration thrombectomy: residual thrombus in mid segment of right coronary artery with restoration of blood flow.

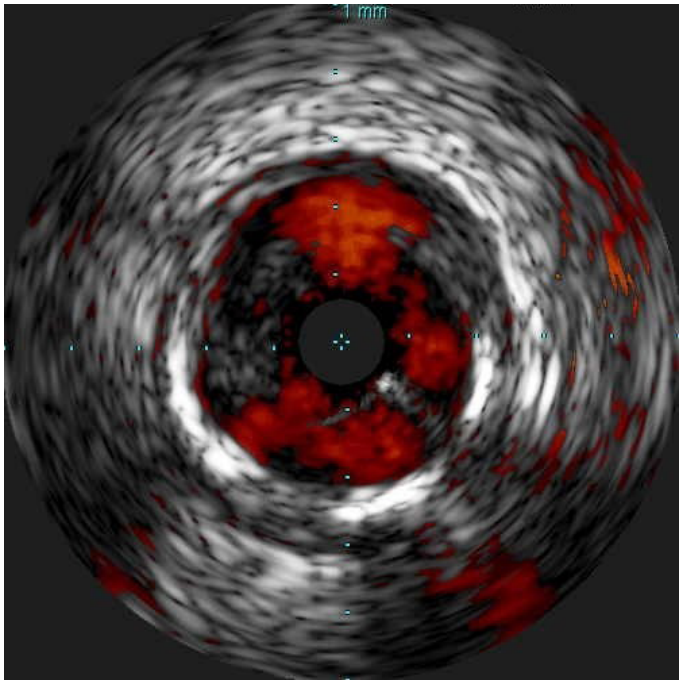


Figure 6 - Intravascular ultrasound – ChromaFlo: Ulcerated atheromatous plaque with residual thrombus.

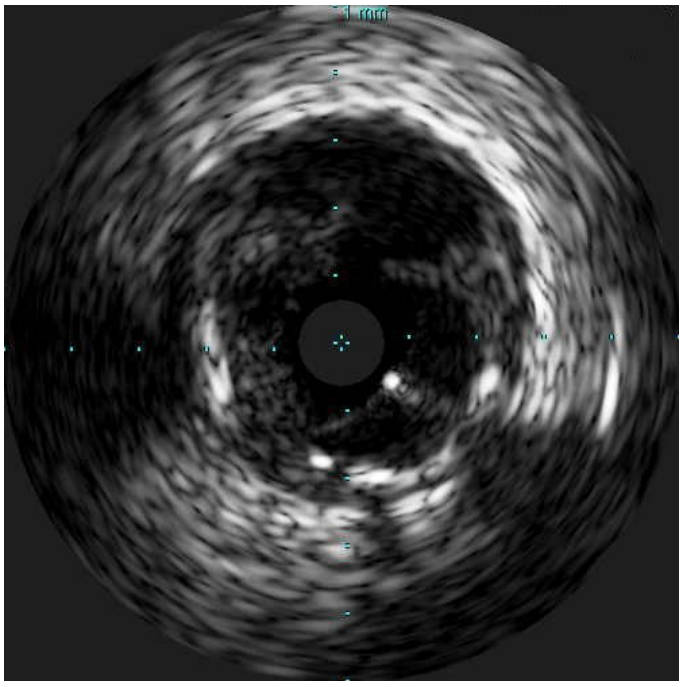


Figure 7 - Intravascular ultrasound – Ulcerated atheromatous plaque with residual thrombus.

less in patients undergoing thrombectomy before stenting compared with controls undergoing stenting without prior thrombectomy [3]. However, this strategy can also be used as bail-out in presence of a high thrombus burden, or if TIMI flow of less than 3 persists despite balloon angioplasty before stenting [4].

The above case highlights the importance of aspiration thrombectomy as possibly the best option in selected cases. Also, IVUS proved that it should be used more often in selected cases,

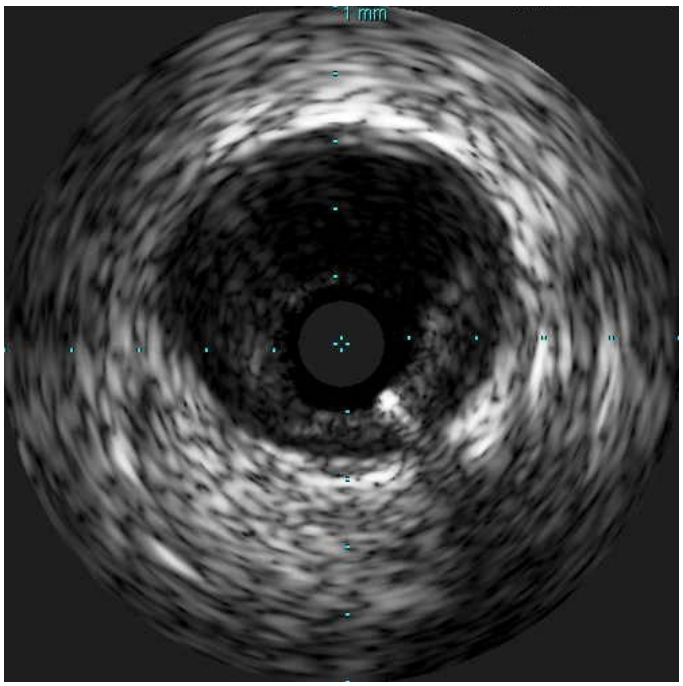


Figure 8 - Intravascular ultrasound – Ulcerated atheromatous plaque with residual thrombus.

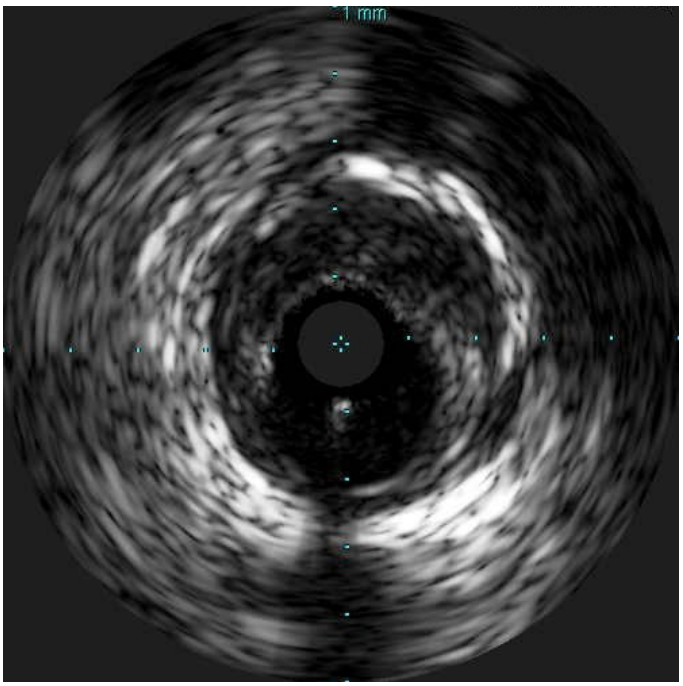


Figure 9 - Intravascular ultrasound – Large plaque burden with eccentric calcification of proximal right coronary artery.

since it could change the whole approach of the PCI [5,6]. Based on IVUS finding, we can defer stenting of insignificant coronary lesion that can be difficult to assess only by angiographic images.

After carefully analyzing the images obtained from IVUS, we decided not to stent the lesions since we hadn't found any residual

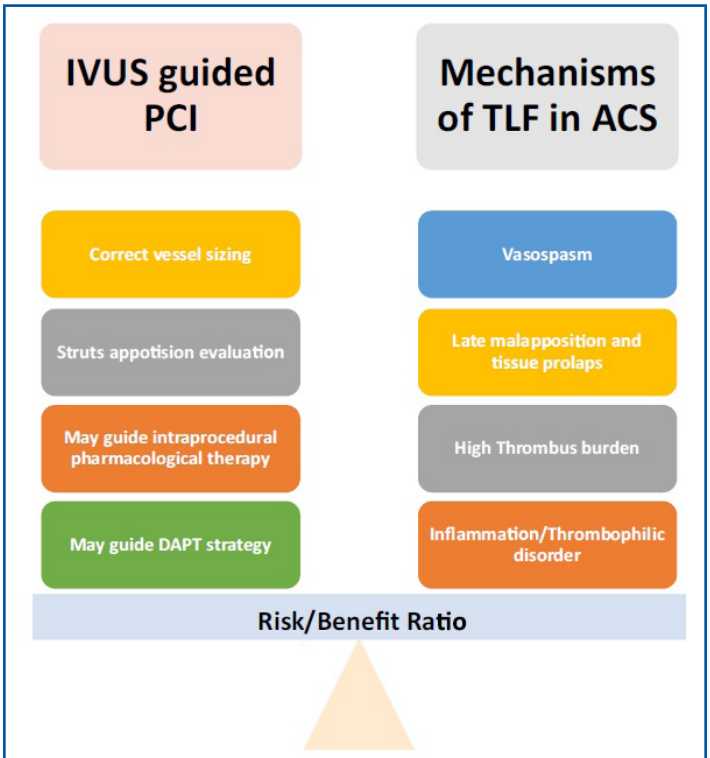


Figure 10 - IVUS: Intravascular Ultrasound. DAPT: Dual Antiplatelet therapy. TLF: Target Lesion Failure. ACS: Acute coronary syndrome. PCI: Percutaneous Coronary Intervention.

stenosis that could jeopardize the patient in the future and implanting a stent would not have a significant advantage in this case. We opted instead for optimal pharmacological treatment and reassessment after 3 months, in order to achieve the best outcome, having in mind that IVUS guided PCI was associated with lower rates of all-cause mortality (RR 0.7; 95% CI, 0.59–0.82; $p < 0.01$), major adverse cardiovascular events (RR 0.86; 95% CI, 0.74–0.99; $p = 0.04$), and target vessel revascularization (RR 0.83; 95% CI, 0.73–0.95; $p < 0.01$) at a median follow up of one year [7] (figure 10).

Conclusions and Implications for Clinical Practice

Coronary angiogram offers limited information for planning the PCI strategy based on anatomical characteristics only, typically in patients with multiple coronary lesions and thrombotic lesions. The most important goal of PCI in a patient with STEMI is to restore the blood flow to relieve the myocardial ischemia as fast as possible. Placing a stent on all coronary lesions seen on coronary angiogram without certifying the impact of these lesions can complicate the procedure and jeopardize the outcome of the patient. There are a lot of data showing that PCI guidance by invasive imagistic and physiological investigation methods improves the outcome of the patient, with clear cut-offs for assessments that can guide us to achieve the best result with an adequate percentage of MACEs at the mid-term follow-up [8].

Conflict of interest

none declared.

REFERENCES

1. Lotfi A., et al. Expert consensus statement on the use of fractional flow reserve, intravascular ultrasound, and optical coherence tomography: a consensus statement of the Society of Cardiovascular Angiography and Interventions. Catheter Cardiovasc Interv, 2014; 83(4):509-18.

2. de la Torre Hernandez J.M., et al. Prospective application of pre-defined intravascular ultrasound criteria for assessment of intermediate left main coronary artery lesions results from the multicenter LITRO study. J Am Coll Cardiol, 2011; 58(4):351-8.

3. Svilaas T., et al. Thrombus aspiration during primary percutaneous coronary intervention. N Engl J Med 2008 Feb 7.

4. Marquis-Gravel G., et al. Technical consideration in acute myocardial infarction with cardiogenic shock: A review of antithrombotic and PCI therapies. Catheter Cardiovasc Interv. 2020 Apr 1; 95(5):924-31.

5. Predescu L.M., Tirlea M., Ciudin R., Deleanu D. The value of invasive hemodynamic and imagistic evaluation to define the right PCI strategy. Romanian Journal of Cardiology 2019; 29(2):256-61.

6. Predescu L.M., et al., Current treatment of left main coronary artery disease. Cor et Vasa 2016; 58:e328-39.

7.Marengo G., De Filippo O., D'Ascenzo F., Iannaccone M. IVUS guided PCI in patients with acute myocardial infarction - The route toward a "plaque oriented" PCI. Int J Cardiol. 2022 Apr 1; 352:54-5.

8. Hidalgo F, et al. Instantaneous wave-free ratio for guiding treatment of nonculprit lesions in patients with acute coronary syndrome: A retrospective study. Catheter Cardiovasc Interv. 2022 Feb; 99(2):489-96.