

# Thrombus-Demarcated Stenting with Dual-Contrast Imaging: A Novel Approach for Late-ST-Segment Elevation Myocardial Infarction with Unsuccessful Predilatation

Mustafa Oguz, MD<sup>1</sup> Tayyar Akbulut, MD<sup>2</sup> Faysal Saylik, MD<sup>2</sup> Tufan Cinar, MD<sup>1</sup>

<sup>1</sup> Department of Cardiology, Sultan Abdülhamid Han Training and Research Hospital, Istanbul, Turkey

<sup>2</sup> Department of Cardiology, SBU Van Training and Research Hospital, Van, Turkey

**Address for correspondence** Mustafa Oguz, MD, Sultan Abdülhamid Han Training and Research Hospital, Tıbbiye Str, Uskudar, 34678, Istanbul, Turkey (e-mail: drmustafaoguz@hotmail.com).

Int J Angiol

## Abstract

### Keywords

- ▶ acute myocardial infarction
- ▶ thrombus-demarcated stenting
- ▶ dual-contrast imaging

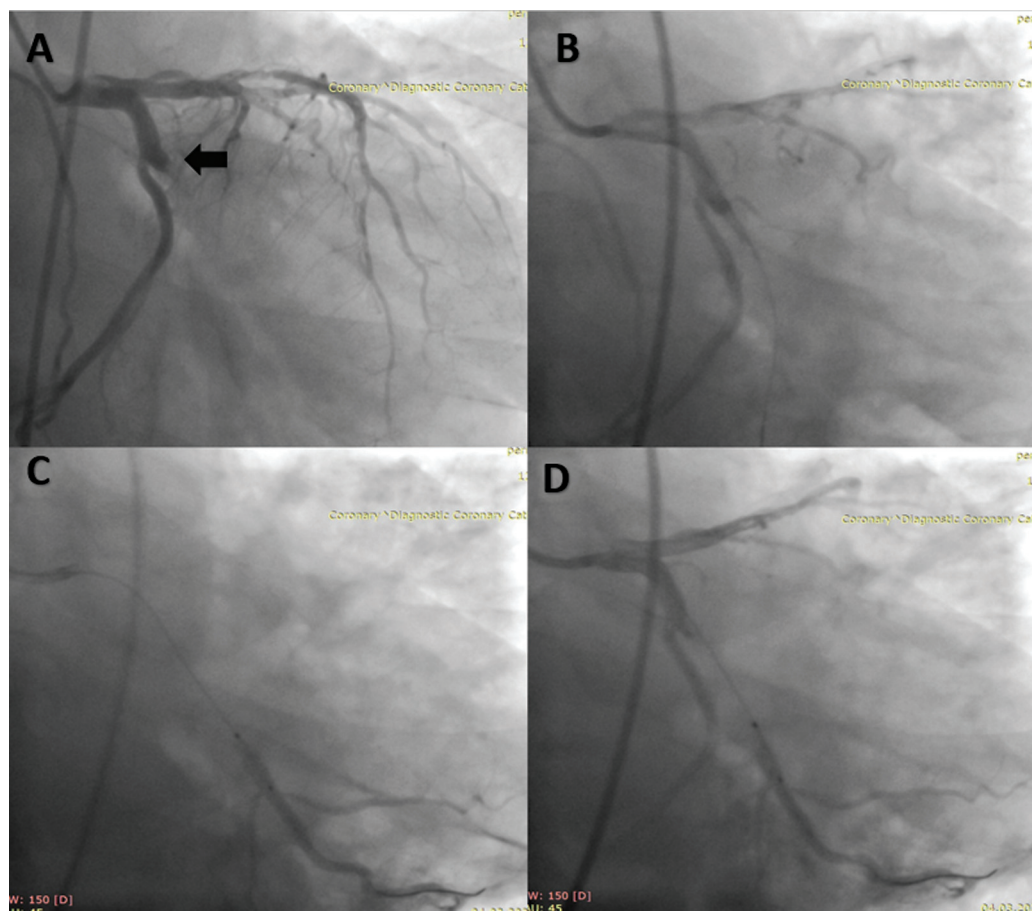
The success of revascularization in the total occluded coronary lesion with dense thrombus burden is important for the short- and long-term prognosis of patients with acute ST-segment elevation myocardial infarction (STEMI). In these lesions, stenting without dispersing the thrombus can increase the success of revascularization without fatal complications. The aim of this case is to demonstrate the newly developed thrombus-demarcated stenting with dual-contrast imaging approach after unsuccessful predilatation in a late-inferior STEMI. In centers where optical coherence tomography is not available, this technique can be used as an alternative.

Late presentation of ST-segment elevation myocardial infarction (STEMI), which occurs in approximately 10 to 12% of patients, refers to cases in which patients present with symptoms 12 hours or more after onset. This life-threatening condition may present with various clinical manifestations.<sup>1,2</sup> Despite significant advances in interventional cardiology, the management of STEMI still presents several challenges, especially in the presence of dense organized thrombus.<sup>3</sup> This may lead to complications such as distal thrombus embolization, undersized stenting, subintimal false lumen crossing, and no-reflow, ultimately reducing the success of revascularization and adversely affecting short- and long-term prognosis.<sup>4,5</sup> In late-acute MI, antegrade flow may not be achieved due to failed thrombus aspiration and predilatation caused by thrombus organization.<sup>6,7</sup> Even when optimal epicardial flow is achieved, distal embolization can sometimes cause microvascular obstruction, resulting in a larger infarct size, reduced ventricular function, and a shorter life expectancy.<sup>6,8</sup> In the presence of dense thrombus that completely cuts off the antegrade

coronary flow, concurrent imaging of the proximal and distal margins of the atherothrombotic lesion and confirming the distal artery size due to possible spasm and then stenting the lesion to prevent distal embolization may improve revascularization success.

## Case Presentation

A 56-year-old woman with essential hypertension and type 2 diabetes mellitus presented to the cardiology outpatient clinic with angina pectoris (Canadian Cardiovascular Society classification 3) of 22 hours' onset (late presentation) and ongoing chest discomfort. Electrocardiogram showed ST elevation in the inferior leads, T-wave inversion, and reciprocal ST-depression in the aVL. Echocardiogram showed basal posterior wall hypokinesia with mild decreased left ventricular ejection fraction. Late-acute inferior MI was diagnosed and urgent coronary angiography was performed. In the case presenting with late-acute inferior MI, unfractionated heparin and dual antiaggregant therapy are given



**Fig. 1** Coronary angiography showing totally occluded thrombi in the proximal left circumflex artery (arrow) (A). Despite the predilatation and manual thrombus aspiration, the antegrade flow was failed (B). The confirmation of distal lumen size via contrast dye injection into the distal lumen through the punctured balloon (C). The demarcation of proximal and distal borders of the thrombotic lesion with dual contrast injection (D).

before the intervention. As radial access was unsuccessful, femoral access was preferred. 6F Judkins left (JL) 4 catheter was preferred.

The angiography revealed a totally occluded thrombi in the proximal left circumflex coronary artery (► **Fig. 1A**). Despite the ballooning of the lesion with  $2.0 \times 12$  mm semicompliant balloon and  $2.5 \times 12$  mm semicompliant balloon as well as manual thrombus aspiration, the distal flow could not be achieved (► **Fig. 1B**). Since the distal flow could not be achieved with predilatation, our plan is to demarcate the proximal and distal portion of the totally occluded lesion using a new technique as described step by step in the below part.

## Steps of Thrombus-Demarcated Stenting with Dual-Contrast Imaging Technique

### Step 1: Balloon puncture and distal contrast injection

The semicompliant predilatation balloon was gently (4–6 atm) inflated and punctured four times using a syringe needle tip. Contrast material was injected through the tip of the punctured balloon, the air remaining in the lumen of the balloon was expelled, and the contrast material output

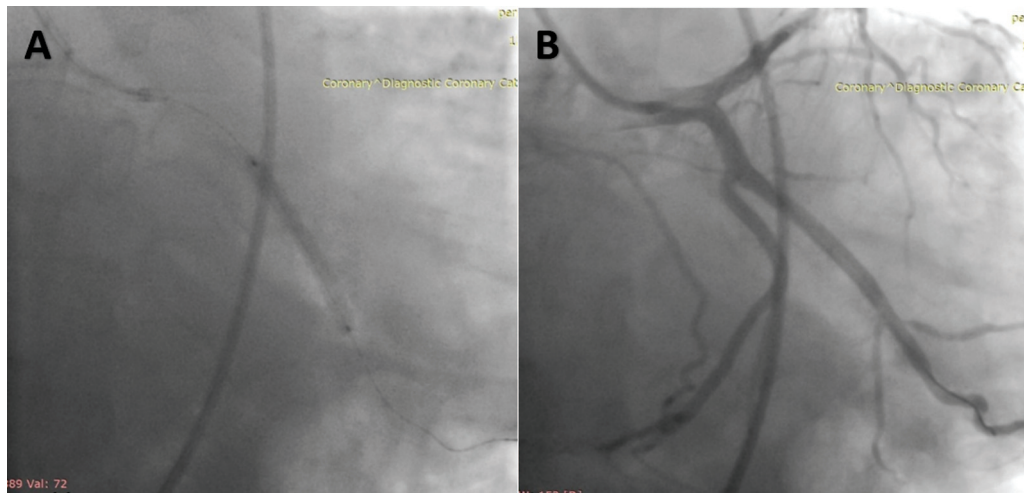
from the punctured balloon was confirmed. ► **Video 1** shows the amount of contrast dye exiting the tip of the punctured balloon. The punctured balloon was then loaded onto a floppy wire and prepared to inject any drug or contrast agent into the distal lumen.

### Video 1

Contrast dye coming out of the tip of a punctured balloon. Online content including video sequences viewable at: <https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0044-1782621>.

### Step 2: Cross the lesion and give vasodilator

First, the thrombotic lesion was crossed with a punctured  $2.5 \times 12$  mm semicompliant balloon and the balloon was suctioned with an inflator to remove air from the system. After confirming the true distal lumen with a tip injection,  $200 \mu\text{g}$  isosorbide mononitrate was administered into the distal lumen according to the patient's blood pressure.



**Fig. 2** Stent implantation based on the lesion's borders and sizes (A). The thrombolysis in myocardial infarction flow III after stent implantation (B).

**Step 3:** Demarcating proximal and distal borders of the thrombotic lesion with dual-contrast imaging

Contrast material was injected into the distal lumen through the punctured balloon until it was completely filled. The entire distal lumen size was confirmed (►Fig. 1C). After the distal lumen had been filled, the proximal lumen of the thrombotic lesion was visualized by administering contrast material through a 6F 4 JL catheter, and the proximal lumen size was confirmed. Thus, the proximal and distal borders of the thrombotic lesion were demarcated (►Fig. 1D).

**Step 4:** Stenting the demarcated thrombotic lesion

A 3.5 × 30 mm drug-eluting stent was implanted based on the lesion's borders and sizes (►Fig. 2A). Finally, the post-dilatation was performed with a 4.0 × 12 mm noncompliant balloon. Final coronary angiogram demonstrated a thrombolysis in myocardial infarction flow III (TIMI) (►Fig. 2B). ►Video 2 shows all the steps of the procedure in sequence.

#### Video 2

All the steps of the procedure in sequence. Online content including video sequences viewable at: <https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0044-1782621>.

## Discussion

In STEMI, rapid and effective revascularization of the completely occluded lesion is crucial for the patient's short- and long-term prognosis. In some cases, TIMI III flow may not be achieved due to the presence of massive and/or organized thrombus. In such lesions, the development of no-reflow, the use of undersized or inadequate length of stents, subendothelial crossing, and distal thrombus embolization may adversely affect the final flow. In addition, the effect of the

initial antegrade flow through the lumen partially revascularized by predilatation may cause microthrombi to occlude the distal microvascular coronary artery bed, leading to enlargement of the infarct area and ultimately affecting the patient's prognosis.<sup>6,9</sup> In late-acute MI, the thrombus may become organized over time, making predilatation and aspiration difficult in achieving antegrade flow.<sup>10–12</sup> As demonstrated in this case, these complications may be difficult to overcome with the conventional approach. Stenting of an atherothrombotic lesion with demarcated borders can reduce many complications during primary coronary intervention. In this case, we imaged the vascular lumen out of the thrombosed regions, identified the proximal and distal borders of the acute atherothrombotic lesion by dual-contrast injection, and stented the lesion directly. We were able to achieve TIMI III flow despite failed predilatation and thrombus aspiration. This novel approach may lead to less thrombus embolization, reducing the risk of no-reflow and disruption of microvascular flow. Furthermore, our new approach may increase the likelihood of successful revascularization by minimizing predilatation and stent implantation in the wrong lumen because the true lumen can be imaged without predilatation.

The microcatheter is commonly used for distal tip injection, but limits the volume of contrast dye that can be administered due to the thin distal tip while on the guidewire. To overcome this limitation, we used a punctured balloon, which allowed us to inject a larger volume of contrast while on the guidewire.

Rapid revascularization is very important in primary percutaneous intervention. However, we believe that once the operator gains experience, this novel approach may not take longer time than conventional methods.

## Limitations

Although a better image can be obtained by injecting contrast dye into the distal lumen with a catheter with an open distal tip, such a catheter was not available or known at the time of

the procedures discussed above, and a punctured balloon was used for distal injection. Furthermore, this technique cannot be used in atherosclerotic or calcific lesions with severe stenosis underlying the total thrombosed lesion because the stent platform may not be able to pass through the lesion without predilatation. On the other hand, the ideal method to define thrombus borders is to use optical coherence tomography (OCT), but its high cost and limited availability in all centers may make it impractical as a routine diagnostic tool. Therefore, this method may serve as an alternative in cases where OCT is not available. It is worth noting that this new approach has only been applied in a few cases.

## Conclusion

In selected cases where conventional revascularization approaches have failed due to long-standing organized coronary thrombus, this novel thrombus-demarcated stenting with dual-contrast imaging approach may be considered as an alternative to improve revascularization success, especially in centers where intracoronary imaging modalities are not available.

### Funding

None.

### Conflict of Interest

None declared.

## References

- 1 Cho KH, Han X, Ahn JH, et al; KAMIR-NIH Investigators. Long-term outcomes of patients with late presentation of ST-segment elevation myocardial infarction. *J Am Coll Cardiol* 2021;77(15):1859–1870
- 2 Vargas-Fernández R, Chacón-Díaz M, Basualdo-Meléndez GW, et al. Late myocardial reperfusion in ST-elevation myocardial infarction: protocol for a systematic review and meta-analysis. *BMJ Open* 2022;12(09):e059610
- 3 Takeji Y, Shiomi H, Morimoto T, et al; CREDO-Kyoto AMI Registry Wave-1 and the CREDO-Kyoto AMI Registry Wave-2 Investigators. Changes in demographics, clinical practices and long-term outcomes of patients with ST segment-elevation myocardial infarction who underwent coronary revascularisation in the past two decades: cohort study. *BMJ Open* 2021;11(03):e043683
- 4 Fajar JK, Heriansyah T, Rohman MS. The predictors of no reflow phenomenon after percutaneous coronary intervention in patients with ST elevation myocardial infarction: a meta-analysis. *Indian Heart J* 2018;70(suppl 3, suppl 3):S406–S418
- 5 Ahn SG, Choi HH, Lee JH, et al. The impact of initial and residual thrombus burden on the no-reflow phenomenon in patients with ST-segment elevation myocardial infarction. *Coron Artery Dis* 2015;26(03):245–253
- 6 Sathananthan J, Watson TJ, Murdoch D, et al. Management of intracoronary thrombus. 2018 Jul 14. In: Watson TJ, Ong PJL, Tchong JE, editors. *Primary Angioplasty: A Practical Guide* [Internet]. Singapore: Springer; 2018. Chapter 10
- 7 Eriksen E, Herstad J, Pertiwi KR, et al. Thrombus characteristics evaluated by acute optical coherence tomography in ST elevation myocardial infarction. *PLoS One* 2022;17(04):e0266634
- 8 Antoniucci D, Valenti R, Migliorini A, et al. Direct infarct artery stenting without predilatation and no-reflow in patients with acute myocardial infarction. *Am Heart J* 2001;142(04):684–690
- 9 Henriques JP, Zijlstra F, Ottervanger JP, et al. Incidence and clinical significance of distal embolization during primary angioplasty for acute myocardial infarction. *Eur Heart J* 2002;23(14):1112–1117
- 10 Rezaq A, Saad M. Thrombus aspiration in late presenters with ST-elevation myocardial infarction: a single-center randomized trial. *J Interv Cardiol* 2018;31(05):632–639
- 11 Kramer MC, van der Wal AC, Koch KT, et al. Presence of older thrombus is an independent predictor of long-term mortality in patients with ST-elevation myocardial infarction treated with thrombus aspiration during primary percutaneous coronary intervention. *Circulation* 2008;118(18):1810–1816
- 12 Bolognese L. Late primary angioplasty (beyond 12 h): are we sure it should be avoided? *Eur Heart J Suppl* 2021;23(suppl E):E36–E39