



# Cardiac magnetic resonance-guided recanalization for left anterior descending artery chronic total occlusion: a case description

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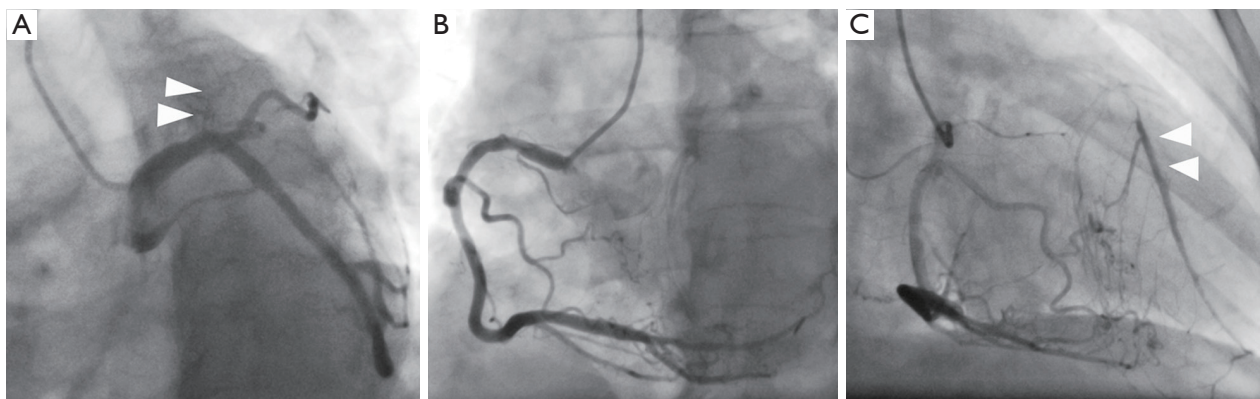
## Introduction

Despite the patency rate of chronic total occlusion (CTO) lesions being significantly improved due to technological advancements in percutaneous coronary intervention (PCI) (1), patient selection for CTO PCI should involve a consideration of myocardial viability to determine the potential clinical benefit (2). Here, we present a case treated with cardiac magnetic resonance (CMR)-guided PCI for left anterior descending artery (LAD) CTO with severe calcification.

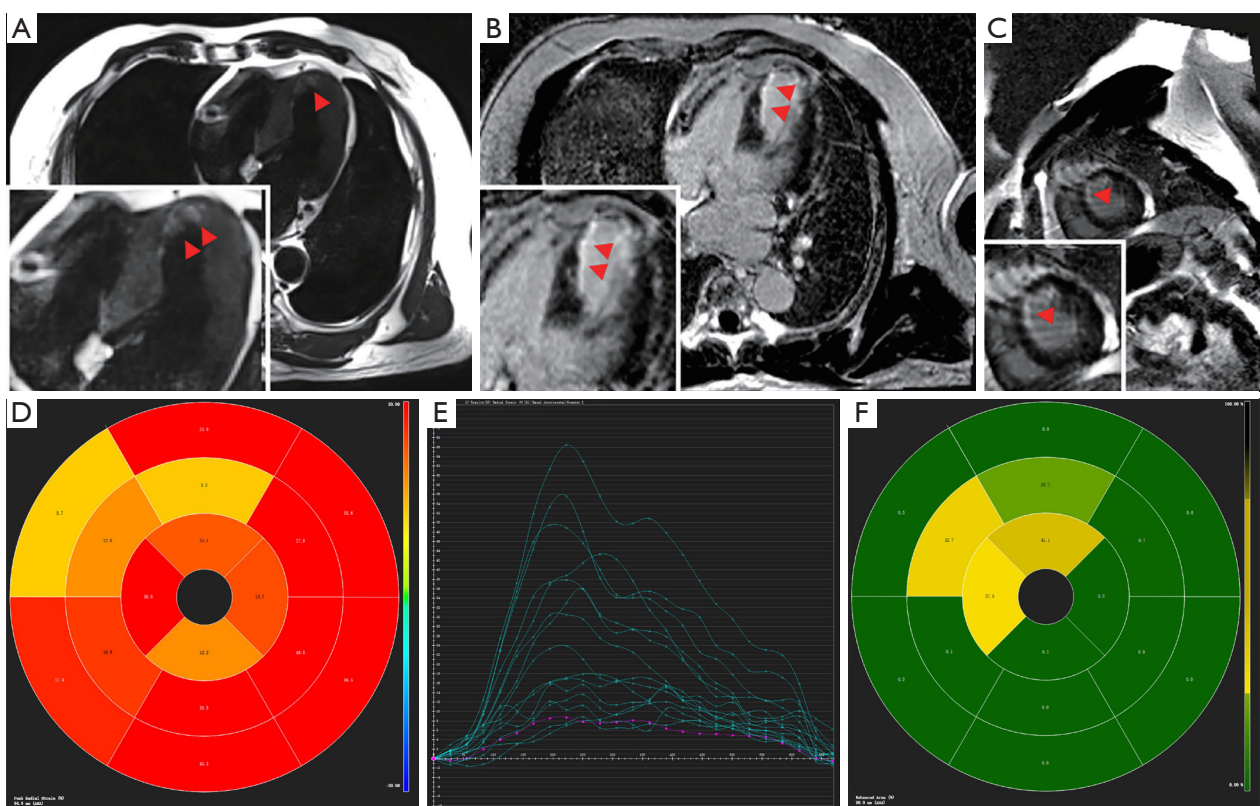
## Case presentation

All procedures performed in this study were in accordance with the ethical standards of the relevant institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal. In another hospital, eight months before attending our hospital, a 63-year-old male patient underwent diagnostic coronary angiography, which revealed severe stenosis in the left circumflex artery (LCX) and right coronary artery (RCA) as well as a CTO lesion in the LAD with grade 2 Werner collateral channels communicating to the LAD from the posterior branches of the left ventricle (LV). Two drug-eluting stents were implanted in the LCX

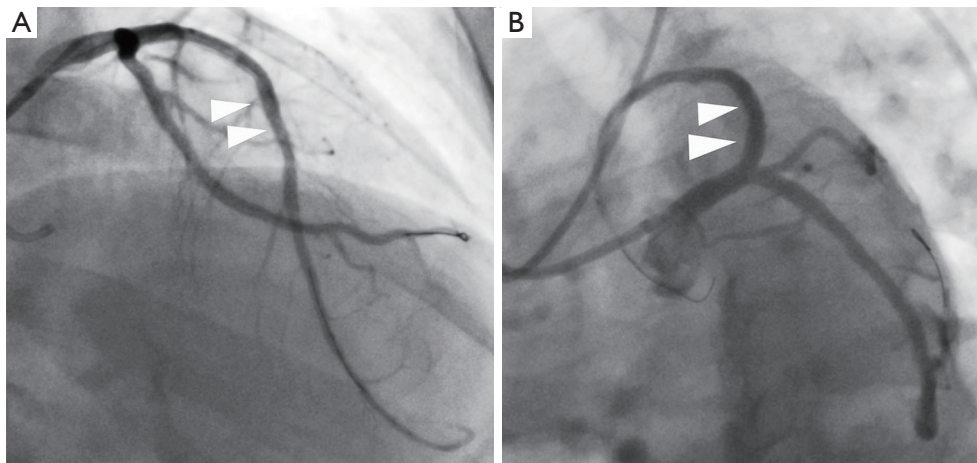
(2.75 mm × 36 mm and 3.0 mm × 28 mm), and one was implanted in the RCA (3.5 mm × 36 mm) (*Figure 1A-1C*); meanwhile, conservative management was applied to the CTO. Transthoracic echocardiography (TTE) revealed an LV ejection fraction of 53% and an LV end-diastolic diameter of 63 mm with anterior wall myocardial thinning and motion hypokinesis. From then on, the patient received optimal drug treatment as recommended by the guidelines (3,4). However, due to recurrent symptom of chest distress lasting 2 months, he came to our hospital for further treatment. The admission examination showed a slight increase in the patient's troponin level (0.10 ng/mL; reference value: 0–0.04 ng/mL). Additionally, the results of the treadmill exercise test were positive. We performed CMR examination on the patient to assess myocardial ischemia and viability in the CTO-subtended territory and determine the appropriate treatment approach, as a correlation between collateral flow and myocardial viability is lacking (5). CMR imaging showed subendocardial infarction in the anteroseptal and apical LV walls, with reduced myocardial strain in these segments (*Figure 2A-2E*). The extent of late gadolinium enhancement (LGE) was 20.4% (*Figure 2F*). According to previous study, the optimal cutoff value of LGE extent is less than 50% for detecting segments, indicating that the segments may functionally recover via CTO lesion revascularization (6). At the heart-team meeting, the patient was discussed in terms of symptoms (recurrent chest distress after optimal medical



**Figure 1** Angiography results before PCI. (A) Spider view of the angiography result of the LAD before PCI revealed no in-stent restenosis in the LCX. The white arrows indicate the occluded LAD. (B) No in-stent restenosis in the RCA. (C) Angiography results indicated grade 2 Werner collateral channels communicating from the posterior branches of the LV to the LAD. The white arrows indicate the collateral channels. PCI, percutaneous coronary intervention; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; LV, left ventricle.



**Figure 2** Results of the CMR examination before PCI for LAD-CTO. (A) T2WI showed myocardial edema in the anteroseptal and apical LV walls before PCI. (B,C) LGE-MRI showed LV subendocardial infarction before PCI. (D,E) Myocardial strain analysis showed decreased parameter values in the anteroseptal and apical LV walls before PCI. (F) The extent of LGE in the territory of LAD before PCI. The red arrows indicate myocardial edema (A) and subendocardial infarction (B,C), respectively. CMR, cardiac magnetic resonance; PCI, percutaneous coronary intervention; LAD, left anterior descending artery; CTO, chronic total occlusion; T2WI, T2-weighted imaging; LV, left ventricle; LGE-MRI, late gadolinium enhancement magnetic resonance imaging.



**Figure 3** Angiography results for the LAD after PCI. Cranial view (A) and spider view (B) of angiography results showed stent implantation for the LAD after PCI. The white arrows indicate stent implantation. LAD, left anterior descending artery; PCI, percutaneous coronary intervention.

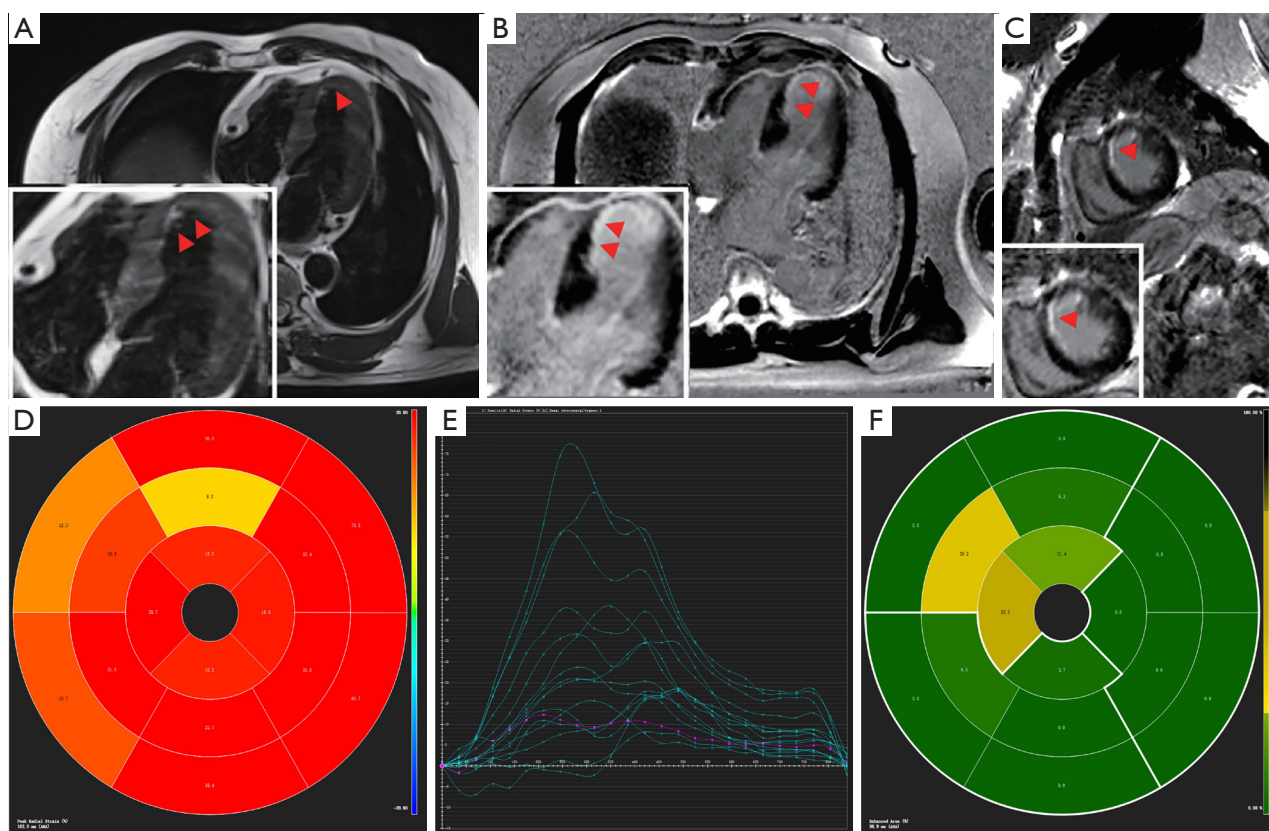
treatment) and angiography and CMR results (the extent of LGE was 20.4% which, being less than 50%, was predictive of functional recovery following revascularization of CTO), and PCI of the LAD-CTO with a primary antegrade strategy was scheduled. The treatment was performed via the left radial artery with a 7-Fr guiding catheter (LA6EBU375; Medtronic). A 6-Fr 3.5 Judkins right catheter was used for contralateral angiography. Initial attempts to deliver Fielder XT-R, Gaia first and Gaia second guidewires in sequence through the occluded segment of the LAD failed. Subsequently, a Gaia third wire was introduced and inserted successfully via antegrade wire escalation to open the occluded segment of the LAD. Three drug-eluting stents (3.0 mm × 36 mm, 3.0 mm × 36 mm, and 4.0 mm × 14 mm) were implanted in the LAD after rotational atherectomy with a 1.5-mm burr at 170,000 rpm for 80 seconds, and thrombolysis in myocardial infarction (TIMI) III flow (normal flow with complete filling of the distal territory) was ensured after stent implantation (*Figure 3*). Four months after PCI, the patient's symptoms markedly improved, and LV function slightly increased. CMR results showed significant improvement in myocardial strain in the anteroseptal and apical LV walls (*Figure 4*). The patient did not experience chest distress (New York Heart Association class I) during the 1-year clinical follow-up. In addition, the patient's Seattle Angina Questionnaire results also showed significant improvement.

## Discussion

PCI implemented via noninvasive imaging guidance, including echocardiography, computed tomography, nuclear scintigraphy, and CMR, has been reported to improve survival after revascularization in patients with coronary artery disease (7). CMR is a high-resolution imaging system that accurately evaluates cardiac dimensions and function and provides valuable information about myocardial viability with high sensitivity and specificity (6). In this case report, we describe a 63-year-old man undergoing PCI guided by CMR to address LAD-CTO.

Thus far, only a few randomized trials evaluating the safety and efficacy of CTO PCI have been conducted, with results being fairly equivocal. Moreover, the results of several observational studies appear inconsistent (8). In patients with multivessel coronary artery disease including a CTO, stenting obstructive non-CTO lesions while treating the CTO medically has been an alternative strategy that has been applied in real-world practice (9). However, whether all similar patients should undergo CTO PCI is unclear.

The relevant guidelines indicate that CTO PCI should be considered in patients who still have symptoms of angina pectoris after drug treatment is optimized or if a large-area ischemia has been confirmed in the territory of the occluded vessel (class recommendation: IIa; level of evidence: B) (10). Myocardial viability and ischemia are



**Figure 4** Results of CMR examination after PCI for LAD-CTO. (A) T2WI showed myocardial edema in the anteroseptal and apical LV walls after PCI. (B,C) LGE-MRI showed LV subendocardial infarction after PCI. (D,E) Myocardial strain analysis showed that the parameters had improved significantly after PCI. (F) The extent of LGE in the territory of the LAD after PCI. The red arrows indicate myocardial edema (A) and subendocardial infarction (B,C), respectively. CMR, cardiac magnetic resonance; PCI, percutaneous coronary intervention; LAD, left anterior descending; CTO, chronic total occlusion; T2WI, T2-weighted imaging; LV, left ventricle; LGE-MRI, late gadolinium enhancement magnetic resonance imaging.

predictors of response to revascularization, and multiple noninvasive imaging modalities are available for evaluating them (11). CMR is a noninvasive, high-resolution imaging technique that evaluates the function and structure of the cardiovascular system. It uses multiparameter, multiplanar, and multisequence imaging to accurately display heart anatomical structures, such as myocardium, chambers, and valves; evaluate regional and global LV function; and detect the presence and the extent of myocardial infarction and ischemic burden. Compared with other noninvasive imaging techniques, CMR has the unique advantage simultaneously and directly imaging infarcted myocardium or scars with the normal myocardium (12). In a retrospective study of 59 patients, the functional improvement was significant after CTO PCI in the regions with a transmural LGE extent  $\leq 50\%$ , but there was no change in the region with LGE

$>50\%$  (13). In our case, the patient experienced recurrent chest distress after optimal medical treatment, and there was clinical evidence of myocardial ischemia. Relieving symptoms and improving the patients' quality of life remains the main indication for CTO PCI. Moreover, patients with ischemic cardiomyopathy who have viable myocardium may benefit from CTO PCI. CMR imaging can not only depict the structure and function of the heart but can also provide an evaluation of myocardial perfusion and myocardial injury patterns (14). Routine CMR is sufficient for evaluating myocardial viability, providing an important reference for CTO preoperative decision-making. In our case, CMR imaging importantly showed inducible ischemia in the territory of the LAD-CTO. Therefore, the anticipated benefits of the patient exceeded the potential risks which might have been caused by the procedure, and CTO-PCI

was thus considered appropriate. Four months after PCI, CMR reexamination showed significant improvement in myocardial strain in the anteroseptal and apical LV walls. The patient had no further symptoms during 1 year of follow-up.

In conclusion, assessing myocardial viability and inducible perfusion defects in the CTO territory before PCI through CMR can help identify those patients who are more likely to benefit from CTO PCI. This case may serve as a reference for using CMR to evaluate and follow up patients with CTO lesions in clinical practice.

## Conclusions

We report a case treated with CMR-guided PCI for LAD-CTO with severe calcification. The patient with three-vessel coronary artery disease was stented in obstructive non-CTO lesions while conservative management was applied for the CTO; subsequently, revascularization of the CTO under the guidance of CMR was performed after the angina was resistant to intensive medical therapy.

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## Footnote

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <https://qims.amegroups.com/article/view/10.21037/qims-23-894/coif>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research

committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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