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CASE REPORT

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Myocardial ischemia caused by the synergistic effect of myocardial bridge and moderate stenosis: case report

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Abstract

Background Clinical events such as angina pectoris, acute coronary syndrome, and sudden death caused by myocardial bridge (MB) have attracted increasing attention. It is still a challenge to diagnose whether MB can cause the symptoms of patients with MB. For most MB patients, medication remains the primary treatment.

Case presentation This article reports a case of chest pain in a patient with MB in the middle segment of the left anterior descending artery (LAD_m) with moderate stenosis in the proximal segment (LAD_p). Through functional assessment, we found that neither MB nor fixed stenosis had sufficient effect on coronary blood flow to cause myocardial ischemia, but their synergistic effect resulted in myocardial ischemia. Finally, a stent was implanted in LAD_p and good clinical results were achieved.

Conclusions For symptomatic patients with MB combined with fixed stenosis, functional evaluation may be necessary, which has significant guiding significance for treatment strategy selection. For asymptomatic patients, early detection of myocardial ischemia may also improve the prognosis of patients.

Keywords Case report, Myocardial bridging, Functional evaluation, Coronary stenosis, Drug-eluting stents

Introduction

MB is a congenital anatomic abnormality, but it can be associated with a range of serious cardiac events, such as coronary artery spasm [1], angina [2], arrhythmia [3, 4], myocardial infarction [5], and sudden cardiac death [6]. MB is identified as an independent predictor of myocardial infarction with non-obstructive coronary artery [7]. An increased incidence of major adverse cardiovascular events and myocardial ischemia has been observed in patients with MB [8]. Most patients with MB have no obvious clinical symptoms. To date, the etiological diagnosis of myocardial ischemia in patients with MB remains challenging. (1) Directly related to MB; (2) Indirect correlation with coronary artery spasm; (3) It is associated with atherosclerotic coronary artery disease; (4) Clinically unrelated to MB [9, 10]. Unlike the fixed stenosis produced by atherosclerotic plaques, dynamic stenosis caused by MB compression of coronary arteries varies with changes in heart cycle, heart rate, and sympathetic tone. When both exist simultaneously, their effects on distal coronary perfusion are still uncertain, and there is no unified guideline to guide the treatment [11]. For symptomatic MB patients, medical therapy remains the preferred recommended method, and percutaneous coronary intervention or surgery may be considered if ineffective [10]. In this case, we found that myocardial

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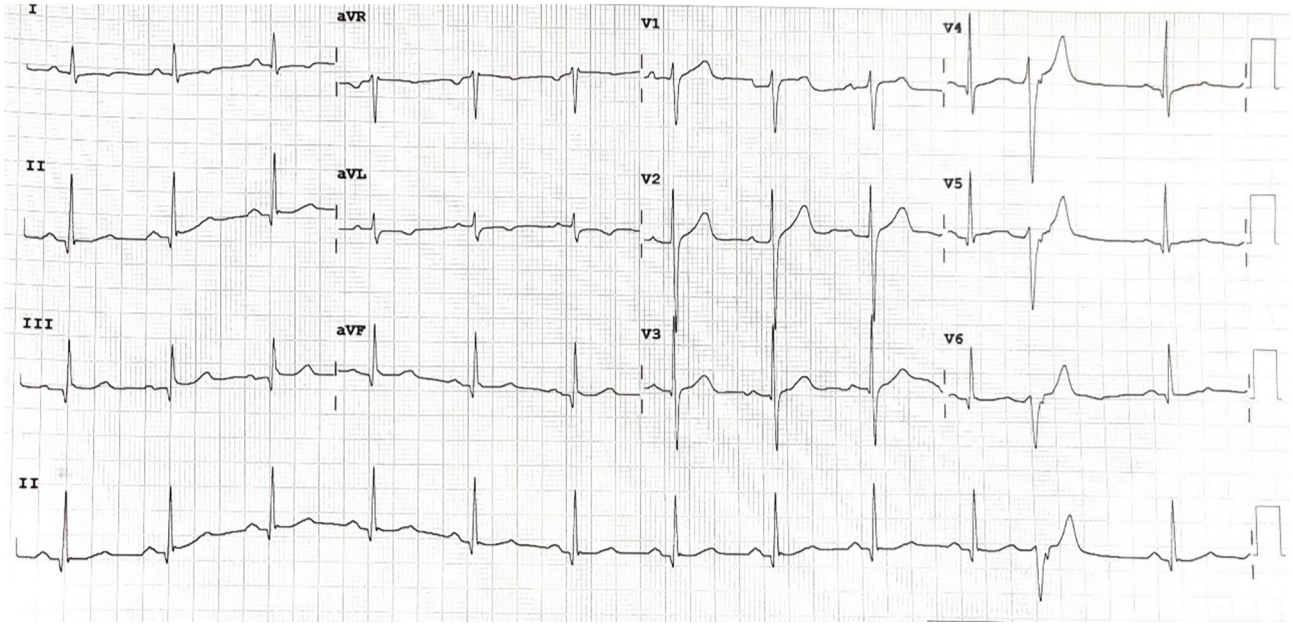

Fig. 1 The patient's ECG on admission.The ECG showed sporadic premature ventricular beats

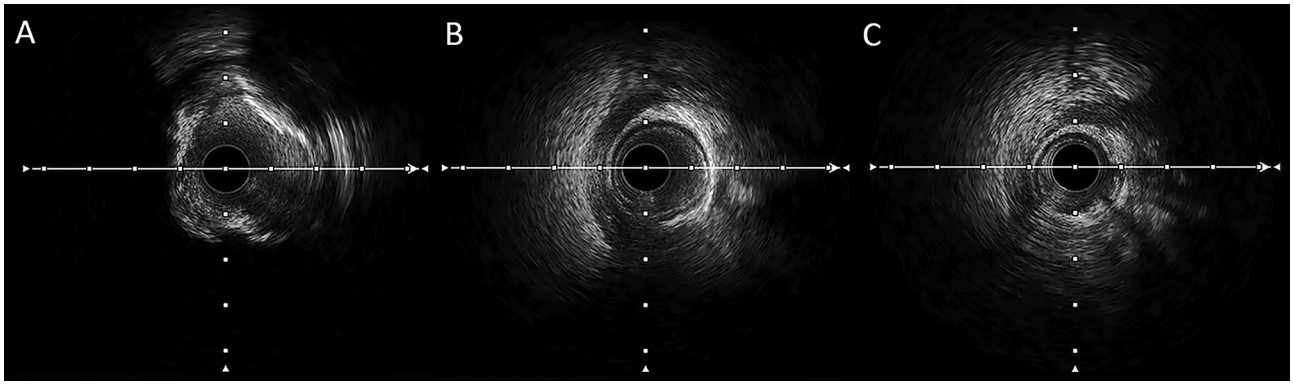

Fig. 2 Results of intravascular ultrasound. (**A**) The proximal stenosis; (**B**) The MB in systole; (**C**) The MB in diastole

ischemia was caused by the synergistic effect of myocardial bridge and moderate stenosis through functional assessment. The patient's chest pain was relieved after stent implantation in the stenosis. In the clinic, physicians should be cautious in the management of patients with MB and fixed stenosis.

Case report

The patient is a 58-year-old male. He had a smoking history of 40 years. He has had hypertension for 7 years, up to 160/110mmHg. His blood pressure was controlled well with perindopril indapamide tablets. He had been diabetic for 23 years and was treated with daily subcutaneous injections of aspartate 30 insulin. His blood glucose control result was unknown (not systematically tested). He complained of chest pain with no obvious cause 5 years ago, located in the precardiac region, radiating back for a few seconds, resolved with rest, and no systemic treatment was performed. Three years ago, he was treated in a Chinese medicine clinic and intermittently took Chinese medicine for a year (the details are unknown), but his symptoms still recurred. In the past half month, the above symptoms worsened and accompanied by palpitations, and dizziness. He went to the Shenyang Central Hospital, where he was treated with metoprolol succinate, aspirin, and atorvastatin calcium, but his symptoms were not significantly relieved. The patient's physical examination showed no abnormality. The patient had no family history of the disease. The patient's ECG on admission showed sporadic premature ventricular beats (Fig. 1). In addition to the high blood glucose test results, other laboratory tests and cardiac ultrasonography showed no abnormality.

To determine the cause, coronary angiography and intravascular ultrasound (Fig. 2) were performed. LADp showed moderate stenosis, and LAD_m showed

myocardial bridging (Supporting information: Video 1). Before implantation of a stent in LADp (Fig. 3A), functional assessment showed the coronary fractional flow reserve (FFR) values of coronary artery opening, proximal and distal to the MB were 1.0 (FFR_{a1}), 0.90 (Fig. 3B, FFR_{a2}), and 0.77 (Fig. 3C, FFR_{a3}), respectively. The diastolic fractional flow reserve (dFFR) values of proximal and distal to the MB were 0.85 ($dFFR_{a2}$) and 0.70 ($dFFR_{a3}$), respectively. The fractional flow reserve gradient (ΔFFR) value at the stenosis was 0.10 (ΔFFR_1, FFR_{a1}-FFR_{a2}). The diastolic fractional flow reserve gradient(ΔdFFR) value of the MB was 0.15 ($\Delta dFFR_1$, $dFFR_{a2}$-$dFFR_{a3}$). After implantation of a stent in LADp (Fig. 3D), the FFR values of coronary artery opening, proximal and distal to the MB were 0.99 (FFR_{b1}), 0.97 (Fig. 3E, FFR_{b2}), and 0.89 (Fig. 3F, FFR_{b3}), respectively; The dFFR values of proximal and distal to the MB were 0.96 ($dFFR_{b2}$) and 0.86($dFFR_{b3}$), respectively. The ΔFFR_2 (FFR_{b1}-FFR_{b2}) value was 0.02, and the $\Delta dFFR_2$ ($dFFR_{b2}$-$dFFR_{b3}$) value was 0.10. After stent implantation, the patient's chest pain was significantly improved. The patient has been discharged for about half a year. In a recent outpatient follow-up, the patient had a good prognosis.

Discussion

In this case, we performed a functional assessment of fixed stenosis and MB by FFR, dFFR, ΔFFR, and ΔdFFR. The "FFR≤0.80" and "ΔFFR≥0.2 (1-0.8)" were used as the cut-off value for ischemia due to fixed stenosis [10]. The "dFFR≤0.76" and "ΔdFFR≥0.24 (1-0.76) " are the cut-off value for functional evaluation of MB [12]. Before stent implantation, ΔFFR_1 value was 0.10(<0.20), and $\Delta dFFR_1$ value was 0.15(<0.24), indicating that neither fixed stenosis nor MB was sufficient to cause myocardial ischemia. However, FFR_{a3}=0.77 and $dFFR_{a3}$=0.70 indicated distal myocardial ischemia in the LAD. Combined with the patient's typical angina symptoms and functional evaluation results, a stent was implanted to the fixed stenosis. After stent implantation, the FFR_{b3} value was 0.89 and the $dFFR_{b3}$ was 0.86. Nearly half a year follow-up, the patient's clinical symptoms improved significantly.

Currently, there is no uniform clinical guidance for the treatment of MB. It is mainly based on case reports and expert opinion and also involves decisions made by individual clinicians [11]. For symptomatic MB patients, β-blockers and non-dihydropyridine calcium channel blockers are routinely used as first-line medical therapy. For patients who cannot tolerate β-blockers and calcium channel blockers, ivabradine is a second-line option for pharmacotherapy [13]. For patients with refractory

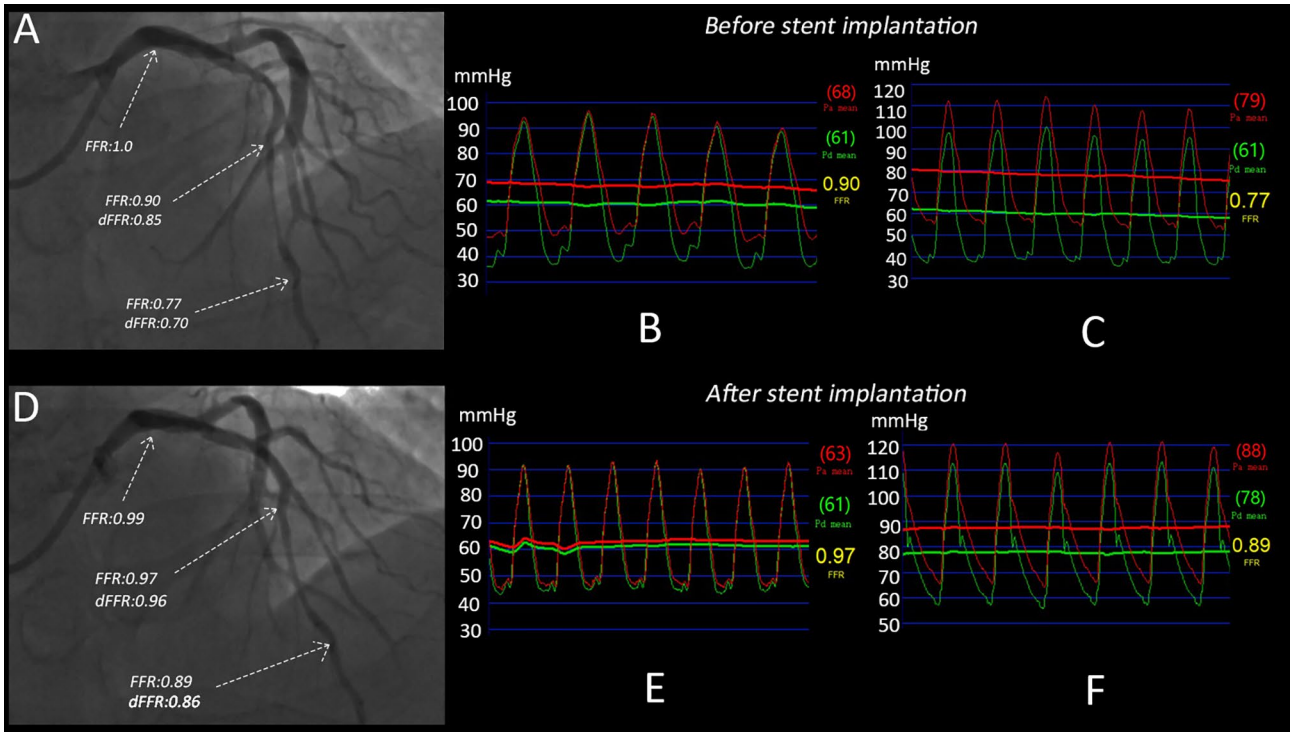

Fig. 3 Results of functional assessment. (**A**) Before stent implantation, the FFR was 1.0, 0.90, 0.77 at coronary opening, proximal MB and distal MB; the dFFR was 0.85, 0.70 at proximal MB and distal MB; (**B**) The FFR result at proximal MB before stent implantation; (**C**) The FFR result at distal MB before stent implantation; (**D**) After stent implantation, the FFR was 0.99, 0.97, 0.89 at coronary opening, proximal MB and distal MB; the dFFR was 0.96, 0.86 at proximal MB and distal MB; (**E**) The FFR result at proximal MB after stent implantation; (**F**) The FFR result at distal MB after stent implantation

symptoms, invasive treatment strategies such as percutaneous coronary intervention and cardiac surgery may be considered [10]. However, percutaneous coronary intervention within MB has limited efficacy in addressing ischemic symptoms. In addition, there is a high risk of early in-stent restenosis, target vessel revascularization, stent fracture, perforation, and thrombosis [14, 15]. Additionally, cardiac surgeries, including coronary artery bypass grafting (CABG) and supra-arterial myotomy, appear to be more effective than percutaneous coronary intervention. Nevertheless, these procedures still face the risks of surgical trauma, graft occlusion, necrosis, and a higher late recurrence rate of angina [16, 17].

In this case, the patient had multiple consultations at different hospitals and was treated with β-blockers without symptom improvement. Based on the FFR, dFFR, ΔFFR, and ΔdFFR assessment results, a stent was implanted at the proximal fixed stenosis, resulting in a good prognosis and avoiding the risks associated with invasive treatment of MB. For patients with refractory symptoms, functional assessment is necessary when fixed stenosis is encountered with MB. It is noteworthy that ΔFFR and ΔdFFR can further clarify whether ischemia originates from MB, fixed stenosis, or their synergistic effect, thereby better informing clinical strategies. However, invasive FFR assessment faces challenges such as high economic costs, long procedural times, and adverse drug reactions.

Conclusion

In the clinic, MB accompanied by fixed stenosis is not uncommon. In this case, functional evaluation confirmed that neither of them could cause myocardial ischemia, but their synergistic effect resulted in myocardial ischemia. Therefore, for patients combined with MB and fixed stenosis, functional evaluation may be necessary, which has obvious guiding significance for the selection of treatment strategies.

Abbreviations

MB	Myocardial bridge
LAD_p	the proximal segment of the left anterior descending artery
LAD_m	the middle segment of the left anterior descending artery
FFR	Fractional flow reserve
dFFR	Diastolic fractional flow reserve
ΔFFR	Fractional flow reserve gradient
ΔdFFR	Diastolic fractional flow reserve gradient
FFR_{a1}	Fractional flow reserve value of coronary artery opening
FFR_{a2}	Fractional flow reserve value of proximal to the MB
FFR_{a3}	Fractional flow reserve value of distal to the MB
$dFFR_{a1}$	Diastolic fractional flow reserve value of coronary artery opening
$dFFR_{a2}$	Diastolic fractional flow reserve value of proximal to the MB
$dFFR_{a3}$	Diastolic fractional flow reserve value of distal to the MB
FFR_{b1}	Fractional flow reserve value of coronary artery opening after stent implantation
FFR_{b2}	Fractional flow reserve value of proximal to the MB after stent implantation
FFR_{b3}	Fractional flow reserve value of distal to the MB after stent implantation
$dFFR_{b1}$	Diastolic fractional flow reserve value of coronary artery opening after stent implantation
$dFFR_{b2}$	Diastolic fractional flow reserve value of proximal to the MB after stent implantation
$dFFR_{b3}$	Diastolic fractional flow reserve value of distal to the MB after stent implantation
ΔFFR_1	Fractional flow reserve gradient value through the stenosis
$\Delta dFFR_1$	Fractional flow reserve gradient value through the MB
ΔFFR_2	Fractional flow reserve gradient value through the stenosis after stent implantation
$\Delta dFFR_{a2}$	Fractional flow reserve gradient value through the MB after stent implantation

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12872-024-04069-6.

Supporting information_Video 1: Coronary angiography showed moderate stenosis in LAD_p and MB in LAD_m

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Not applicable.

Author contributions

Z. Q. and Q. F. and X.L. the conception and design of the work; H. L. , Z.R. and C.F. the acquisition and analysis of data; Z. Q. wrote original draft; Z. Q. and H. L. and Q. F. reviewed and edited the work; X. L. and Z.Q. prepared Figs. 1, 2 and 3; All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Consent for publication

Written informed consent to publish was obtained from the study participant.

Competing interests

The authors declare no competing interests.

Ethics approval and informed consent

The case was approved by the Medical Ethics Committee of The People's Hospital of Liaoning Province.

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