

## Images in Cardiology

# Structural or Functional Coronary Artery Disease? Acetylcholine Testing Reveals Epicardial Spasm After Multiple Myocardial Revascularizations

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Determining the cause of angina pectoris remains challenging, because structural and functional abnormalities may be involved. We report the case of a 77-year-old male patient who presented with recurrent chest pain. His past medical history was notable for a single coronary bypass of a proximal left anterior descending artery (LAD) stenosis in 1989, using the left internal thoracic artery (LITA). Prior to this operation, the patient had reported angina occurring predominantly at rest but also occasionally on exertion. Interestingly, the symptoms did not improve after the bypass operation. After degeneration of the LITA-bypass, coronary bypass surgery was repeated, with a venous graft to the LAD, in 1995. The patient reported ongoing symptoms, with chest pain occurring predominantly at rest and during the night. He also reported radiation of pain into the throat area. In addition, during or after each chest pain attack, he had a persistent trembling in the extremities and a strong feeling of being cold. He continued to be severely impaired in his daily activities. Several coronary angiographies were performed in search of progression of coronary artery disease and showed a patent venous LAD-bypass (Fig. 1A).

In 2016, another angiogram revealed occlusion of the LAD-bypass. Subsequently, percutaneous coronary intervention of the LAD was performed, with 3 stents (Fig. 1B). Even after this intervention, his condition did not improve, and his complaints persisted,<sup>1</sup> although antianginal drugs such as amlodipine and carvedilol were initiated. In 2020, a myocardial scintigraphy examination did not reveal any reversible ischemia.

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**Ethics Statement:** We confirm that our research complies with current ethical guidelines.

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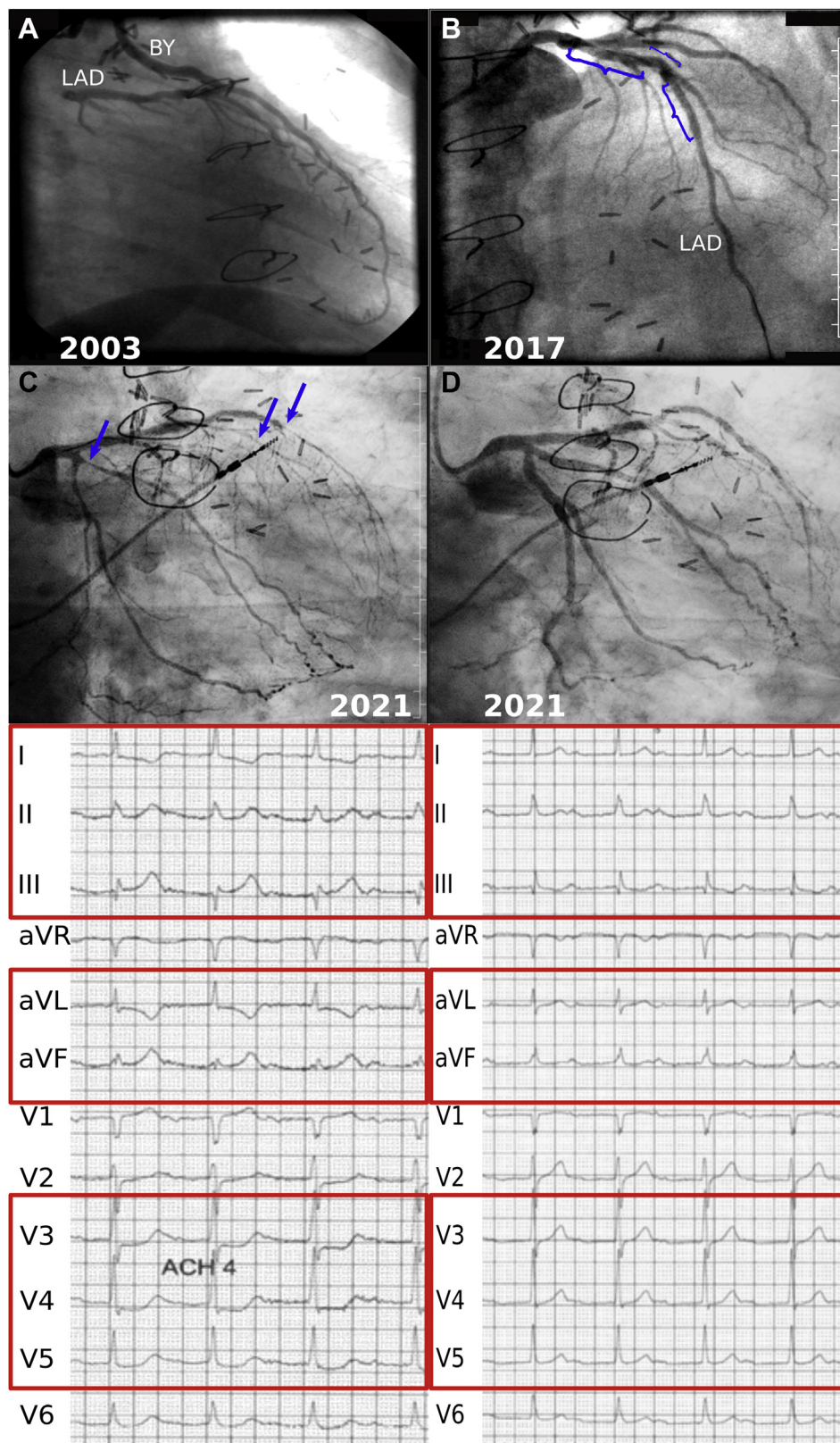
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### Novel Teaching Points

- In patients with previous coronary revascularisations and resting angina coronary spasm should be suspected.
- A comprehensive assessment of coronary vasomotor disorders can be done by an invasive diagnostic procedure using acetylcholine and adenosine.
- Assessment of coronary flow reserve during acetylcholine testing may objectively confirm coronary spasm in addition to other established diagnostic criteria.

Finally, we decided to perform an invasive diagnostic procedure, suspecting that a coronary vasomotor disorder was the cause of the symptoms, in 2021.<sup>2</sup> Intracoronary acetylcholine testing revealed diffuse epicardial spasms of the LAD distal to the stents, as well as of the left circumflex artery (Fig. 1C).<sup>3</sup> The spasms were accompanied with reproduction of the patient's symptoms and ischemic electrocardiogram changes (Fig. 1, D and E). Concomitant assessment of coronary flow using a dedicated wire during acetylcholine testing revealed a coronary flow reserve (CFR<sub>ACH</sub>, is calculated from APV under ACh 200 µg divided by the APV before ACh testing) of 1.6. Coronary flow reserve and hyperaemic microvascular resistance in response to intracoronary adenosine were within normal limits (2.7 and 1.4 mm Hg/cm per second, respectively). Ranolazine and carvedilol were discontinued, and treatment with a second calcium antagonist (ie, diltiazem) in addition to amlodipine was initiated. At follow-up, the patient's angina had significantly improved.

Coronary spasm in patients who have undergone previous bypass operation but have no relevant stenosis is not an infrequent finding. In a recent study by Pirozzolo et al., it was shown that 81% of such patients had epicardial or microvascular spasm during acetylcholine testing via the LITA graft.<sup>4</sup> In contrast, spasm of the bypass graft could not be documented. However, this type of spasm has been described in the intra- or perioperative phase.<sup>5</sup> Thus, chest pain at rest,



**Figure 1.** (A) Patent left anterior descending (LAD) artery–bypass (BY). (B) LAD artery after successful percutaneous coronary intervention (3 stents, brackets). (C) Acetylcholine (200 µg) testing showed diffuse spasm of the LAD artery, second diagonal and focal spasm in the first obtuse marginal branch (blue arrows), together with symptom reproduction and ischemic electrocardiogram changes (red boxes below left). (D) Nitroglycerine (200 µg) led to resolution of spasm and symptoms and normalization of the electrocardiogram (red boxes below right).

with no significant obstructive disease, should prompt testing for coronary spasm in order to initiate appropriate anti-vasospastic medication.

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### Disclosures

The authors have no conflicts of interest to disclose.

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