



Endurance Cycling and Coronary Collateral Development: A Case Report of a Natural Bypass

Emirhan Çakır, Merve Akbulut Çakır, Çağlar Kaya

Trakya University Faculty of Medicine, Department of Cardiology, Edirne, Türkiye

Keywords: Chronic total occlusion, coronary collateral, cycling

Chronic total occlusions (CTOs) are defined as complete blockages of the coronary arteries persisting for at least 3 months.¹ Typically, patients with CTO experience stable angina pectoris unless additional coronary lesions progress, leading to unstable angina. During acute myocardial infarction or elective percutaneous coronary intervention (PCI), the presence of a CTO in one coronary artery that receives blood supply from another via coronary collaterals presents an interventional challenge.^{2,3} Coronary collaterals are natural connections between arteries that facilitate blood flow to the myocardial region supplied by an occluded vessel, partially or fully preserving its integrity. The diameters of these collaterals range from 40 to 200 μm , with most being smaller than the spatial resolution of coronary angiography, limiting their visualization. This report presents a case in which a well-developed coronary collateral, functioning as a natural bypass graft, originates near the right coronary artery (RCA) ostium at the level of the right sinus of Valsalva and extends retrogradely to the left anterior descending (LAD) ostium. Angiographic images will illustrate the case of a patient who underwent coronary angiography due to acute myocardial infarction.

A 67-year-old man with a history of hypertension presented to the emergency department with epigastric pain. He had no prior history of angina pectoris or angina-equivalent symptoms and reported long-term participation in cycling. Electrocardiography revealed ST elevation in the inferior leads, prompting his transfer to the coronary angiography laboratory (Figure 1). Imaging of the left coronary system did not reveal the LAD ostium. Given the possibility of separate origins for the LAD and circumflex (CX) arteries, a nonselective search was conducted at the level of the left sinus of Valsalva, but no additional ostium was identified. Consequently, the LAD was presumed to be occluded at its ostium. Additionally, Rentrop 1 collateral flow to the RCA was observed in left system imaging.

Visualization of the right coronary system revealed a proximal total occlusion of the RCA, along with a collateral vessel originating from the RCA ostium and supplying the left system, providing Rentrop 3 flow to the LAD ostium. This collateral had an approximate diameter of 2.6 mm. A thin collateral was also noted extending from the RCA ostium to the LAD ostium. Using a JR4 diagnostic catheter, selective imaging was performed, showing that this collateral supplied retrograde grade 2 flow to the RCA (Figure 2). During selective imaging, the patient's hemodynamic status deteriorated, leading to ventricular fibrillation. Immediate defibrillation was performed, successfully restoring normal sinus rhythm. The patient regained consciousness, and hemodynamic parameters returned to normal.

Selective insertion of the JR4 guiding catheter into the RCA was performed rapidly. A floppy guidewire successfully crossed the total occlusion and was advanced to the distal RCA. After predilatation using a 2.0 \times 15-mm percutaneous transluminal coronary angioplasty balloon, a 2.75 \times 24-mm drug-eluting stent was implanted proximally

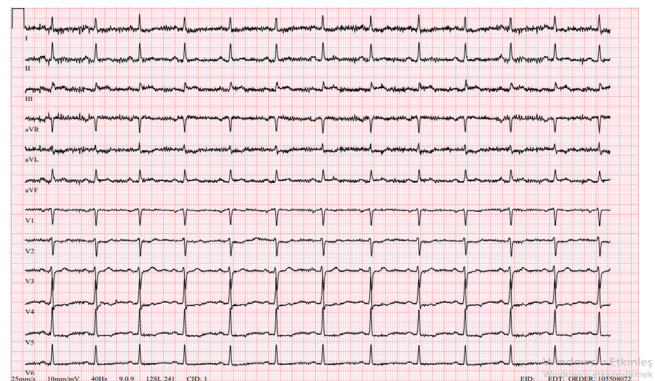


Figure 1. ST elevation in the inferior leads on ECG
ECG: Electrocardiography

Address for Correspondence: Emirhan Çakır MD, Trakya University Faculty of Medicine, Department of Cardiology, Edirne, Türkiye

E-mail: emir.cakir05@gmail.com **ORCID ID:** orcid.org/0000-0002-2231-1526

Cite as: Çakır E, Akbulut Çakır M, Kaya Ç. Endurance cycling and coronary collateral development: a case report of a natural bypass. *Inter Cardio Pers.* [Epub Ahead of Print]

Received: 23.02.2025

Accepted: 17.03.2025

Epub: 20.03.2025

in the RCA with optimal ATM. In-stent optimization was then carried out using a 3.0×20-mm non-compliant balloon, followed by proximal optimization at high ATM. Postprocedure imaging confirmed TIMI-3 distal flow in the RCA, and retrograde flow to the distal LAD was observed after PCI to the RCA. The procedure was successfully completed (Figure 3). The final angiographic image demonstrated a complex circulatory connection between the right and left coronary systems, characterized by a well-developed collateral network and thin collateral vessels. This intricate vascular structure exhibited unique anatomical and physiological properties, functioning as alternative pathways. The patient was scheduled for monitoring in the coronary intensive care unit.

Follow-up transthoracic echocardiography revealed an ejection fraction of 55%, with hypokinesia in the inferior wall of the left ventricle. However, no contraction abnormalities were observed in the myocardial regions corresponding to the LAD territory. The patient remained under observation postprocedure, and medical therapy was adjusted accordingly. Given the presence of a 50-60% intermediate stenosis in the mid-CX region observed on angiography, myocardial perfusion scintigraphy was planned, and the patient was subsequently discharged.

Coronary collateral circulation plays a crucial role in preventing ischemia and offers several benefits, including reducing infarct size,

improving left ventricular function postinfarction, and enhancing long-term survival. Adequate coronary collateral circulation is present in approximately one-third of patients with hemodynamically significant coronary lesions. Identifying the factors that promote the development of this circulation could contribute to better cardiovascular outcomes.

During exercise, both cardiac output and coronary blood flow increase, creating a pressure gradient across a stenotic lesion. This pressure difference directs blood toward anastomotic channels that may serve as precursors for collateral formation. However, multiple studies have not established a clear association between exercise and the development of coronary collaterals in patients with coronary artery disease.

A previous study examining the impact of coronary collaterals on the clinical characteristics of coronary artery disease included 119 patients, comparing 61 patients with angiographically visible collaterals to 58 patients without collaterals. The study found no significant relationship between collateral presence and a physically active lifestyle.⁴

In another study, 20 male patients with acute myocardial infarction were divided into exercise and control groups. No difference was observed in the development of new collaterals between patients who participated in an exercise program and those who did not.⁵

In our patient, the completely occluded LAD continues to supply blood through a collateral vessel that functions similarly to a natural bypass,

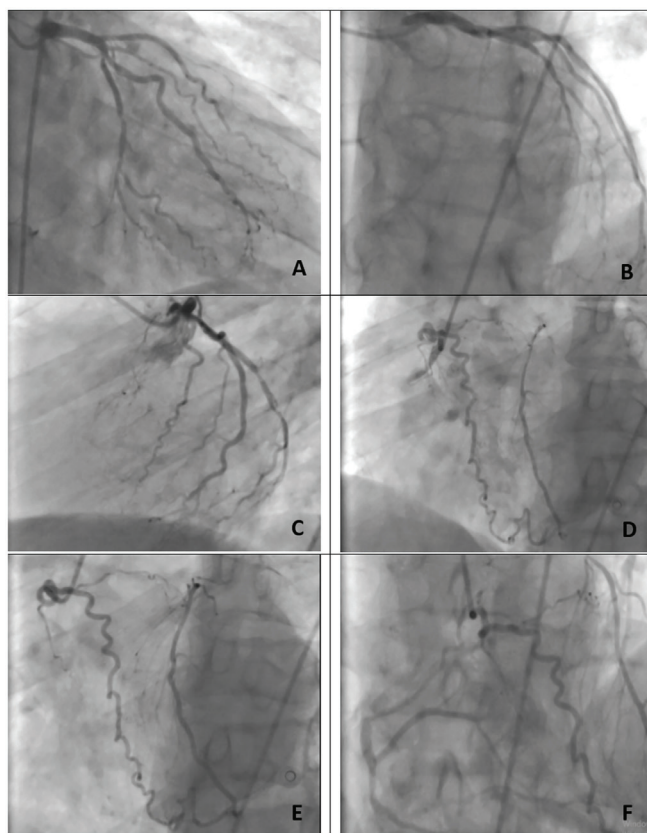


Figure 2. A, B, C) Left-system imaging demonstrates total occlusion of the LAD. D) Right-system coronary imaging reveals proximal total occlusion of the RCA. E) Selective imaging shows Rentrop 3 collateral filling of the LAD. F) The same collateral vessel provides grade 2 retrograde filling of the RCA
LAD: Left anterior descending, RCA: Right coronary artery

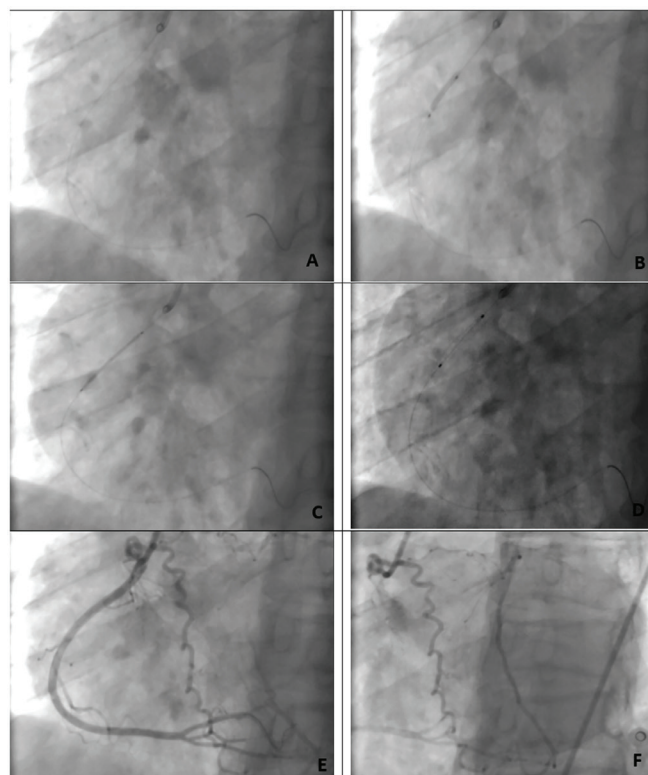


Figure 3. A) Crossing the RCA lesion with floppy guidewire. B) Predilatation of the lesion using a PTCA balloon. C) Proximal stent implantation in the RCA. D) Proximal optimization with an NC balloon following stent placement. E) Postprocedure control image showing TIMI-3 distal RCA flow. F) Final image displaying the RCA, LAD, and collateral vessel
PTCA: Percutaneous transluminal coronary angioplasty, NC: Non-compliant, LAD: Left anterior descending, RCA: Right coronary artery

sustaining a vital ventricular region. This well-developed collateral circulation positively impacts the patient's prognosis by helping prevent complications such as aneurysm formation or heart failure in the left ventricle.

This case highlights that a well-developed collateral in a patient who has dedicated a significant portion of his life to cycling and remains physically active can prevent the onset of anginal symptoms or heart failure.

From this perspective, the case contributes to the literature and may provide insights for future large-scale studies on the potential positive impact of exercise and lifestyle on cardiovascular outcomes.

Informed Consent: Informed consent was obtained from the patient for the article.

Authorship Contributions: Concept: E.Ç., M.A.Ç., Ç.K., Design: E.Ç., M.A.Ç., Ç.K., Data Collection or Processing: E.Ç., M.A.Ç., Ç.K., Analysis or Interpretation: E.Ç., M.A.Ç., Ç.K., Literature Search: E.Ç., M.A.Ç., Ç.K., Writing: E.Ç.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Di Mario C, Werner GS, Sianos G, et al. European perspective in the recanalisation of chronic total occlusions (CTO): consensus document from the EuroCTO Club. *EuroIntervention*. 2007;3:30-43.
2. van der Schaaf RJ, Vis MM, Sjaauw KD, et al. Impact of multivessel coronary disease on long-term mortality in patients with ST-elevation myocardial infarction is due to the presence of a chronic total occlusion. *Am J Cardiol*. 2006;98:1165-1169.
3. Migliorini A, Valenti R, Parodi G, et al. The impact of right coronary artery chronic total occlusion on clinical outcome of patients undergoing percutaneous coronary intervention for unprotected left main disease. *J Am Coll Cardiol*. 2011;58:125-130.
4. Helfant RH, Vokonas PS, Gorlin R. Functional importance of the human coronary collateral circulation. *N Engl J Med*. 1971;284:1277-1281.
5. Nolewajka AJ, Kostuk WJ, Rechnitzer PA, Cunningham DA. Exercise and human collateralization: an angiographic and scintigraphic assessment. *Circulation*. 1979;60:114-121.