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ZERO CORONARY CALCIUM DESPITE SEVERE LEFT ANTERIOR DESCENDING ARTERY STENOSIS IN A HIGH TAKE-OFF SINGLE CORONARY ARTERY WITH PREPULMONIC LEFT MAIN COURSE – A CLINICAL CASE

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НУЛЕВ КОРОНАРЕН КАЛЦИЕВ СКОР ВЪПРЕКИ ТЕЖКА СТЕНОЗА НА ПРЕДНАТА НИЗХОДЯЩА КОРОНАРНА АРТЕРИЯ ПРИ ЕДИНИЧНА КОРОНАРНА АРТЕРИЯ С ВИСОКО ИЗХОДНО МЯСТО И ПРЕПУЛМОНАЛЕН ХОД НА СТВОЛА НА ЛЯВАТА КОРОНАРНА АРТЕРИЯ – КЛИНИЧЕН СЛУЧАЙ

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Abstract. A high-take-off single coronary artery is a rare congenital coronary anomaly that may complicate coronary angiography and percutaneous coronary intervention. A 35-year-old man presented with anterior ST-segment elevation myocardial infarction (STEMI). Initial coronary angiography was limited by difficulty in selective engaging the anomalously located coronary ostium, resulting in inadequate contrast opacification. Coronary computed tomography angiography (CCTA) subsequently demonstrated a single high-take-off coronary ostium arising from the ascending aorta, with a prepulmonic course of the left main coronary artery. Despite a coronary artery calcium score of 0, severe approximately 80% proximal left anterior descending artery (LAD) stenosis was identified (CAD-RADS 4A). Repeat invasive coronary angiography demonstrated 95% subtotal proximal LAD occlusion with a hazy appearance suggestive of active thrombus. Primary PCI with two overlapping drug-eluting stents restored TIMI grade 3 flow without procedural complications . This case highlights the value of CCTA in defining anomalous coronary anatomy and demonstrates that a calcium score of 0 does not exclude clinically significant obstructive coronary disease.

Key words: single coronary artery, high-take-off coronary ostium, ST-segment elevation myocardial infarction, percutaneous coronary intervention

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Резюме. Единичната коронарна артерия с високо начало е рядка вродена коронарна аномалия, която може да затрудни провеждането на коронарна ангиография и перкутанна коронарна интервенция. 35-годишен мъж постъпи с преден миокарден инфаркт с елевация на ST-сегмента (STEMI). Първоначалната коронарна ангиография беше затруднена поради трудности при селективното достигане на аномално разположеното устие на коронарната артерия, което доведе до недостатъчно контрастно запълване. Впоследствие коронарната компютърно-томографска ангиография (CCTA) показа единичен коронарен остиум с висок изход, произхождащ от възходящата аорта, с предбелодробен ход на лявата главна коронарна артерия. Въпреки калциев скор на коронарните артерии от 0, бе установена тежка стеноза от приблизително 80% в проксималната част на лявата предна низходяща артерия (LAD) (CAD-RADS 4A). Повторната инвазивна коронарна ангиография показа 95% субтотална проксимална оклузия на LAD със замъглен вид, подсказващ наличие на активен тромб. Първичната PCI с два припокриващи се стента с лекарствено покритие възстанови TIMI 3 кръвоток без процедурни усложнения. Този случай подчертава значението на CCTA за определяне на аномална коронарна анатомия и показва, че калциев индекс 0 не изключва клинично значима обструктивна коронарна болест.

Ключови думи: единична коронарна артерия, коронарен остиум с високо начало, миокарден инфаркт с елевация на ST-сегмента, перкутанна коронарна интервенция

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Introduction

Congenital coronary artery anomalies comprise a heterogeneous spectrum of abnormalities involving the origin, course, branching pattern, or termination of the coronary arteries. Although many coronary variants are incidental and hemodynamically insignificant, certain anatomical patterns particularly interarterial or intramural courses may be associated with myocardial ischemia, ventricular arrhythmias, syncope, and sudden cardiac death [1, 3]. Accurate definition of the coronary origin and its relationship to the great vessels is therefore essential for risk stratification and for planning invasive or surgical procedures.

A single coronary artery (SCA) is an uncommon congenital anomaly in which the entire coronary circulation arises from a solitary aortic ostium. Lipton et al. reported an estimated prevalence of approximately 0.024% and proposed an angiographic classification based on the site of origin, branching pattern, and course of the anomalous vessel [1]. In a contemporary coronary computed tomography angiography (CCTA) series of 30,230 examinations, SCA was identified in 0.056% of patients, underscoring the rarity of this anomaly even in large imaging populations [2]. The clinical significance of SCA is determined not only by the presence of a single ostium but also by the subsequent course of the coronary branches and by coexisting atherosclerotic coronary artery disease.

High take-off describes an anomalous coronary origin located unusually superior to the expected sinus of Valsalva level, frequently arising above the sinotubular junction from the ascending aorta. High-origin and prepulmonic coronary courses are generally regarded as lower-risk configurations than an interarterial course when they occur without other high-risk anatomical features; however, they remain clinically important because an ectopic ostial position may complicate selective catheter engagement, coronary angiography, percutaneous coronary intervention, and cardiac surgery [3, 4]. Recent reports continue to emphasize the diagnostic difficulty of high-take-off coronary arteries during invasive angiography and the value of cross-sectional imaging for defining their exact origin and trajectory [6].

CCTA is particularly useful for suspected coronary anomalies because it provides high-resolution, three-dimensional visualization of the coronary ostia, proximal course, and relationship to the aorta and pulmonary artery, while simultaneously assessing concomitant coronary plaque and luminal stenosis [3, 5]. We report a young adult with a high-take-off single coronary ostium arising from the ascending aorta, forming a common coronary trunk that gives rise to the right coronary artery and left main coronary artery, with a prepulmonic/anterior course of the left coronary system. The anomaly was accompanied by severe proximal left anterior descending artery stenosis and marked myocardial injury, illustrating the importance of distinguishing the congenital coronary configuration from coexisting acquired obstructive coronary disease.

Case Presentation

A 35-year-old man presented to the emergency department after experiencing intermittent central chest pain for three days. Approximately seven hours before presentation, the chest pain became sustained and more severe, radiating to the back and accompanied by chest tightness, dyspnea, and palpitations. The patient had a known history of hypertension and diabetes mellitus. A 12-lead electrocardiogram demonstrated an anterior ST-segment elevation myocardial infarction (STEMI) and raised value of troponin I about > 15 ng/mL, documented as having an onset of approximately 7 hours, with Killip class I at presentation. Plasma glucose was raised about 398 mg/dL. Initial coronary angiography was performed after admission (Fig. 1); however, adequate visualization of the coronary circulation was difficult because contrast opacification and flow through the coronary system were suboptimal. The patient was treated with aspirin 80 mg once daily, clopidogrel 75 mg once daily, atorvastatin 40 mg once daily, nitroglycerin 2.5 mg, bisoprolol 1.25 mg once daily, and alprazolam 0.5 mg.

Coronary computed tomography angiography (CCTA) was subsequently performed to clarify the coronary anatomy and guide further management. CCTA demonstrated a rare congenital coronary anomaly consisting of a single coronary ostium with a high-take-off origin from the ascending aorta (Fig. 2). The common coronary trunk gave rise to the right coronary artery and the left main coronary artery (LMCA). The LMCA followed an anterior/prepulmonic course relative to the aortic root before bifurcating into the left anterior descending artery (LAD) and left circumflex artery. CT functional analysis demonstrated preserved LV systolic function with an LVEF of 72%. Coronary calcium scoring showed an Agatston score of 0. Despite the absence of detectable coronary calcification, CCTA demonstrated (Fig. 4) severe stenosis of approximately 80% in the proximal LAD, corresponding to CAD-RADS 4A. These findings established the coexistence of a high-take-off single coronary ostium with a prepulmonic left main course and significant obstructive disease of the proximal LAD.

Following anatomical clarification by CCTA, repeat invasive coronary angiography was performed for definitive revascularization. Right femoral arterial access was used with a 6-F sheath. Diagnostic angiography with a Judkins Left 3.5/6-F catheter demonstrated a single high-take-off common coronary ostium arising

from the ascending aorta and subsequently bifurcating into the left main coronary artery and right coronary artery. The left main coronary artery was normal, whereas the proximal LAD showed a 95% subtotal occlusion with a hazy appearance suggestive of active thrombus. The diagonal branches, LCx, obtuse marginal branches, RCA, posterior descending artery, and posterolateral branch showed no significant stenosis, consistent with single-vessel coronary artery disease.

Primary percutaneous coronary intervention of the culprit LAD lesion was subsequently performed. A CLS 3.5/6-F guiding catheter was used to engage the anomalous common coronary ostium, and a Sion Blue guidewire was advanced to the distal LAD. The lesion was predilated using a Sapphire II Pro 2.75 × 15-mm balloon at 6–18 atm. A 3.0 × 33-mm drug-eluting stent was deployed in the proximal LAD at 11 atm and post-dilated to 16 atm. Because the proximal stent edge appeared hazy and raised concern for edge dissection, a second 3.5 × 15-mm drug-eluting stent was implanted proximally with overlap of the first stent, followed by further post-dilatation. Final angiography demonstrated TIMI grade 3 flow with no residual edge dissection or coronary perforation. No procedural complications occurred, and the patient was transferred to the intensive cardiac care unit for post-procedural monitoring.

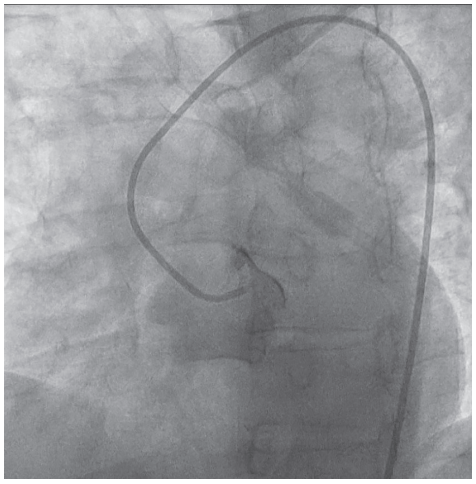

Fig. 1. Initial coronary angiography showing difficulty in selective coronary ostial engagement and inadequate contrast filling of the coronary arteries

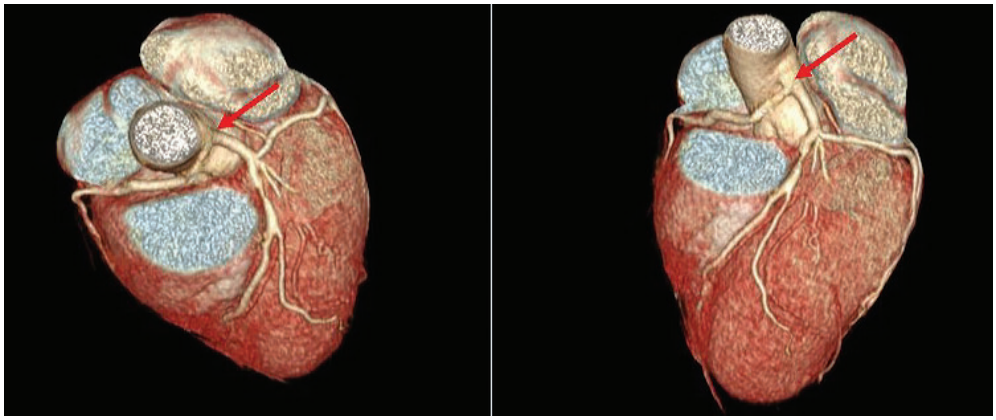

Fig. 2. Three-dimensional volume-rendered coronary computed tomography angiography (CCTA) images demonstrating a single high-take-off coronary ostium arising from the ascending aorta (> 5 mm above the sinotubular junction), giving rise to the right coronary artery (RCA) and left main coronary artery (LMCA). The LMCA follows an anterior/prepulmonic course before bifurcating into the left anterior descending (LAD) and left circumflex (LCx) arteries

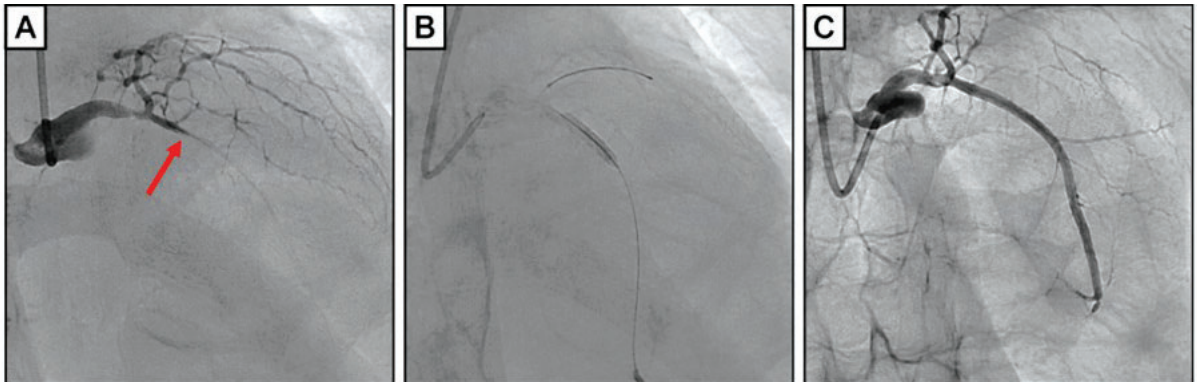

Fig. 3. Invasive coronary angiography demonstrating the sequence of percutaneous coronary intervention in the left anterior descending artery (LAD): **A**) Pre-PCI angiography showing a 95% subtotal occlusion of the proximal LAD with a hazy appearance suggestive of active thrombus; **B**) Balloon predilatation of the proximal LAD lesion prior to stent implantation; **C**) Final angiography after implantation of two overlapping drug-eluting stents, demonstrating restoration of TIMI grade 3 flow without residual edge dissection or coronary perforation

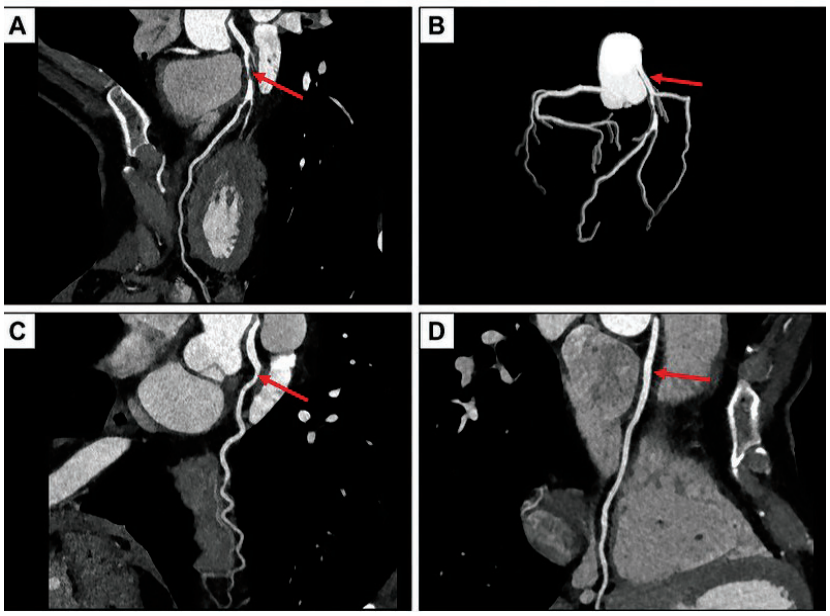

Fig. 4. Coronary computed tomography angiography (CCTA) demonstrating the coronary arterial anatomy: **A**) Curved multiplanar reconstruction of the left anterior descending artery (LAD) showing severe proximal stenosis of approximately 80% (CAD-RADS 4A); **B**) Three-dimensional volume-rendered reconstruction demonstrating the single coronary arterial system arising from a high-take-off ostium in the ascending aorta; **C**) Curved multiplanar reconstruction of the left circumflex artery (LCx) without significant luminal stenosis; **D**) Curved multiplanar reconstruction of the right coronary artery (RCA) showing no significant stenosis

The patient was scheduled for regular follow-up at the cardiology clinic for ongoing clinical evaluation. During outpatient follow-up, the patient remained clinically stable, and the previously reported symptoms had resolved.

Discussion

This case illustrates the coexistence of a rare congenital coronary configuration and an acquired culprit coronary lesion in a young patient presenting with anterior ST-segment elevation myocardial infarction. Single coronary artery is exceptionally uncommon. In a large CCTA series of 30,230 examinations, Michalowska et al. identified only 17 cases, corresponding to a prevalence of 0.056% [2]. The clinical importance of a single coronary artery depends not only on the presence of a solitary ostium but also on the origin, proximal course, ostial morphology, and relationship of the anomalous vessel to the great arteries [1, 3, 4].

The prepulmonic or anterior course identified in this patient is an important anatomical feature. In contrast to interarterial and intramural courses, which have been associated with a higher risk of ischemia and sudden cardiac events, a prepulmonic course is generally considered a lower-risk configuration when other high-risk anatomical features are absent [3,4]. Therefore, the congenital anomaly itself should not automatically be considered the cause of the acute ischemic presentation. In the present case, the severe proximal LAD stenosis provides a more direct anatomical explanation for the anterior STEMI, whereas the high-take-off single ostium primarily influenced diagnostic assessment and procedural planning. Raj et al. recently reported that failure to identify a coronary artery in its expected sinus during invasive angiography may mimic ostial occlusion and lead to repeated catheter manipulation; in their case, CT coronary angiography accurately defined the high origin and subsequent coronary course [6]. Similarly, CCTA in our patient served as a problem-solving modality after the initial angiographic study could not adequately delineate the coronary anatomy, demonstrating the high-take-off single ostium and the relationship of the left coronary system to the great vessels.

An additional strength of CCTA in this case was its ability to evaluate congenital anatomy and acquired coronary disease in a single examination. CCTA demonstrated approximately 80% proximal LAD stenosis, while the remaining major epicardial coronary segments showed no significant stenosis. According to CAD-RADS 2.0, a 70-99% stenosis involving one or two coronary vessels is categorized as CAD-RADS 4A, indicating severe coronary stenosis [9]. Thus, the CCTA findings provided both anatomical clarification of the coronary anomaly and clinically relevant characterization of the culprit coronary lesion.

A particularly noteworthy finding was the presence of severe LAD stenosis despite a total coronary artery calcium score of 0. Although a calcium score of 0 is associated with a low overall probability of obstructive atherosclerotic disease, it does not exclude noncalcified plaque or clinically significant stenosis in symptomatic patients. In the CORE64 substudy, Gottlieb et al. found that 19% of patients with a calcium score of 0 had at least one coronary stenosis of 50% or greater, and 12.5% underwent revascularization; importantly,

20% of totally occluded vessels had no detectable coronary calcium [7]. Similarly, the CONFIRM registry showed that among symptomatic patients with a calcium score of 0, 3.5% had stenosis of at least 50% and 1.4% had stenosis of at least 70% on CCTA [8]. These findings support the concept that absence of coronary calcification should not be interpreted as absence of coronary atherosclerosis, particularly in a symptomatic young patient with objective evidence of acute myocardial ischemia. Repeat invasive coronary angiography was undertaken for definitive revascularization, followed by implantation of two drug-eluting stents in the LAD. Percutaneous coronary intervention in patients with a single coronary ostium requires careful procedural planning because unusual ostial orientation and vessel course may make selective engagement and device delivery technically challenging. In addition, guide-catheter-induced injury or dissection at a solitary coronary ostium may jeopardize a large myocardial territory. Previous reports of PCI in single coronary artery anatomy have therefore emphasized appropriate guiding-catheter selection, stable coaxial support, and cautious catheter manipulation [10]. In the present case, preprocedural anatomical definition by CCTA was particularly valuable before repeat invasive intervention.

Contemporary Bulgarian data provide relevant regional context for these findings. In a series of 9,567 consecutive patients undergoing coronary angiography, Grigorov et al. identified 530 coronary anatomical abnormalities when myocardial bridges and selected variants were included, whereas only 83 patients, or 0.87%, met their definition of a true coronary artery anomaly after exclusion of myocardial bridges and commonly accepted anatomical variants [11]. Importantly, that study classified high take-off and anterior coronary origins as anatomical variants rather than true anomalies. This illustrates how the reported prevalence of coronary anomalies is strongly influenced by the classification system and by whether high take-off anatomy is categorized as an anomaly or a variant [11]. In our patient, however, the relevant anatomy extended beyond an isolated high take-off and included a solitary common coronary ostium supplying both the right and left coronary systems.

The procedural relevance of anomalous coronary anatomy has also been demonstrated in a subsequent Bulgarian analysis. Grigorov et al. reported that obstructive coronary disease was more frequent in anomalous than in normally originating coronary arteries (33.9% vs. 24.2%), with anomalous anatomy remaining independently associated with obstructive disease [12]. Furthermore, anomalies of coronary origin were associated with an additional 3.72 minutes of fluoroscopy time and 49.6 mL of contrast use, while PCI involving anomalous arteries required longer fluoroscopy than PCI of normally originating vessels (median 14.6 vs. 8.4 minutes) [12]. These findings are particularly relevant to the present case, in which recognition of the anomalous ostial location was essential before definitive PCI and influenced the strategy for selective engagement and revascularization.

This case highlights several practical lessons. First, failure to selectively engage or adequately opacify the coronary arteries during angiography should raise suspicion for an anomalous coronary origin, including a high-take-off ostium. Second, CCTA provides valuable three-dimensional information regarding coronary origin, course, and can simultaneously identify significant obstructive disease. Third, a coronary calcium score of 0 does not exclude severe coronary stenosis or an acute coronary event. Finally, recognition of single-ostium anatomy before intervention is important because it may substantially influence catheter selection and procedural strategy.

Conclusion

This case demonstrates the clinical importance of recognizing anomalous coronary anatomy in the setting of acute myocardial infarction. A high-take-off single coronary ostium complicated selective coronary engagement, while CCTA provided essential anatomical clarification and identified severe proximal LAD disease, enabling successful PCI with restoration of TIMI grade 3 flow. The findings also emphasize that a coronary calcium score of 0 does not exclude clinically significant obstructive coronary disease in symptomatic patients. Accurate delineation of coronary origin and course may therefore be crucial for procedural planning and safe revascularization in patients with anomalous coronary anatomy.

Informed Consent – Written informed consent was obtained from the patient for publication of the clinical information and accompanying anonymized images in this case report.

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