JACC: CASE REPORTS VOL. 28, 2023

CASE REPORT

CLINICAL CASE

Calcified Nodule

A Rare Clinical Diagnosis in Patients Presenting With ST-Segment Elevation Myocardial Infarction

Alexander Marschall, MD, Fernando Rivero, MD, PhD, David del Val, MD, PhD, Teresa Bastante, MD, Javier Cuesta, MD, Fernando Alfonso, MD, PhD

ABSTRACT

Calcified nodules (CNs) represent the least common cause of acute coronary syndrome. Furthermore, case reports describing CNs as the underlying cause for ST-segment elevation myocardial infarction are exceptional. We present a patient with ST-segment elevation myocardial infarction caused by a CN and outline the corresponding diagnostic angiographic and intracoronary imaging findings. (J Am Coll Cardiol Case Rep 2023;28:102122) © 2023 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

An 80-year-old man was admitted to the emergency department with ongoing chest pain of 3 hours' onset. On admission, his blood pressure was 160/90 mm Hg, his heart rate was 80 beats/min, and oxygen saturation was 98% (ambient air). His electrocardiogram revealed ST-segment elevation in the inferior electrocardiogram leads (**Figure 1**). Echocardiography showed hypokinesia of the inferior and inferolateral segments (Videos 1 and 2). The patient received 300 mg of acetylsalicylic acid and 180 mg of ticagrelor, and was transferred to the catheterization laboratory for emergent coronary angiography.

LEARNING OBJECTIVES

- To understand the role of CNs in the clinical setting of acute coronary syndrome, especially in ST-segment elevation myocardial infarction.
- To be able to make the diagnosis of CNs on coronary imaging.
- To understand the potential of CNs to create a "double paradox," namely a filling defect on angiography and a bright protruding mass with dorsal shadowing on optical coherence tomography.

PAST MEDICAL HISTORY

Past medical history included arterial hypertension, diabetes mellitus, and chronic kidney disease.

DIFFERENTIAL DIAGNOSIS

Considering the patient's symptoms, the differential diagnosis included myocardial infarction, pericarditis, and pulmonary embolism.

INVESTIGATIONS

Emergent coronary angiography revealed diffuse calcification of the coronary arteries with a calcified, but moderate, lesion on the left anterior descending coronary artery (Video 3). The right coronary artery (RCA) was diffusely calcified and showed a calcified

From the Servicio de Cardiología, Hospital Universitario de la Princesa, IIS-IP, Universidad Autónoma de Madrid, Madrid, Spain.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received September 1, 2023; revised manuscript received October 10, 2023, accepted October 18, 2023.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2023.102122

ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome

CN = calcified nodule

OCT = optical coherence tomography

RCA = right coronary artery

STEMI = ST-segment elevation myocardial infarction

severe lesion in its medial segment and another critical lesion, heavily calcified, presenting as an intraluminal filling defect in its distal segment (culprit lesion), causing TIMI flow grade 1 (**Figures 2A and 2B**, Video 4). The differential diagnosis based on the angiographic images included intracoronary red thrombus and calcified nodule (CN) as the etiology of the acute obstruction of the RCA. After crossing the lesion with a guidewire, anterograde flow (TIMI flow grade 3) was restored, and optical coherence tomography (OCT) was performed (Video 5). OCT revealed a bright, irregular protruding mass casting a major dorsal shadow and small intraluminal thrombotic material at the minimal lumen area (**Figure 2**, panels 2 and 3). Based on the evidence of extensive calcification of the adjacent vessel wall (**Figure 2**, panel 1) and the presence of a distinct superficial bright borderline on top of the protruding tissue, the diagnosis of a CN was made (Video 6).

MANAGEMENT

Given the heavy calcification, which made crossing attempts with several low-profile balloons impossible, application of plaque-modifying technique in the form of rotational atherectomy was necessary. A 1.5-mm bur was used with several passes with success. Subsequently, dilatation of both distal and medial RCA lesions with scoring balloons was performed before drug-eluting stents were implanted in both lesions, achieving an optimal angiographic result with TIMI flow grade 3 (**Figure 2C**, Video 7). Coronary physiological assessment of the left anterior descending coronary artery lesion resulted negative, and consequently, it was left untreated.

DISCUSSION

We present herein a patient with ST-segment elevation myocardial infarction (STEMI) caused by a CN in a native coronary artery and outline in detail the corresponding diagnostic angiographic and intracoronary imaging findings. CNs, defined as heavily calcified protruding plaques with fibrous cap disruption and associated with fibrin-rich thrombus, represent the least common cause of acute coronary syndrome (ACS).[1,2] Its incidence in ACS accounts for 4% to 8%.[1-3] Furthermore, its occurrence in patients presenting with STEMI is remarkably low. Indeed, in the 2 largest studies to characterize the morphological features of culprit lesions by OCT in 126 and 889 ACS patients, CN was the underlying cause of coronary thrombosis in 8% and 4%, respectively.[2,4] However, none of these patients in 1 study and only 4 patients

FIGURE 1 12-Lead Electrocardiogram Showing ST-Segment Elevation in Inferior Leads

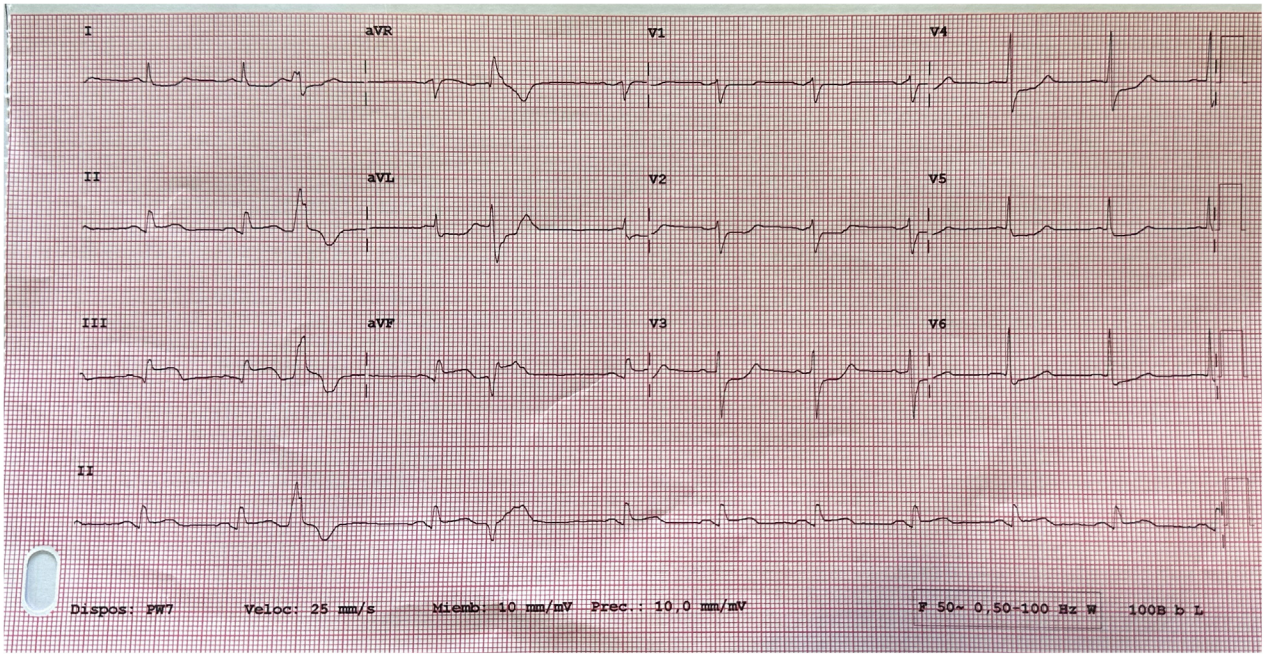
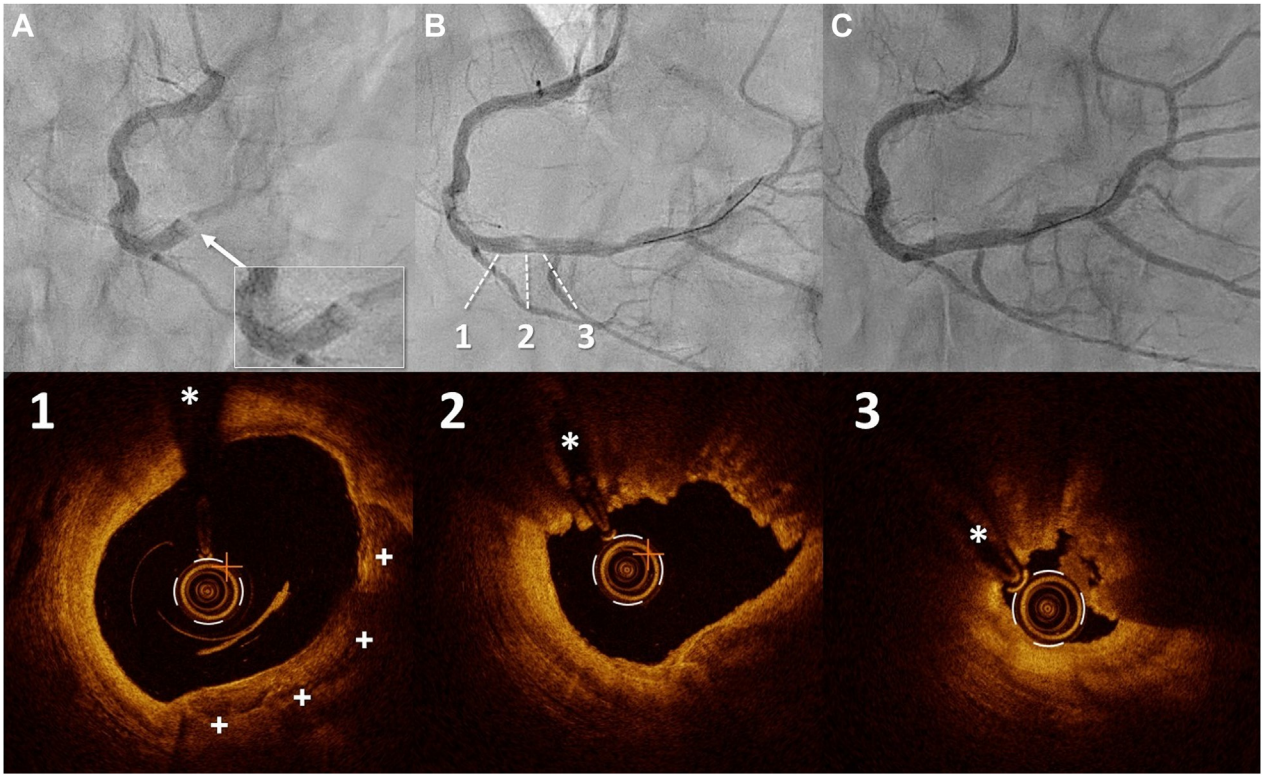


FIGURE 2 **Angiographic and Optical Coherence Tomography Findings of the Right Coronary Artery**



Angiographic (A to C) and optical coherence tomography (OCT) (1 to 3) findings of the right coronary artery (RCA). (A) RCA presenting acute occlusion with intraluminal filling defect (arrow, amplification) causing TIMI flow grade 1. (B) RCA after crossing of the lesion and restoring coronary blood flow. The numbers 1 to 3 represent the corresponding OCT cross sections. (C) Final result with TIMI flow grade 3 after implantation of stents. (1) OCT finding showing heavy calcification (+) of the vessel adjacent to the calcified nodule (CN). (2) OCT image showing protruding tissue casting a major dorsal shadow with a distinct irregular superficial bright border line on top of the protruding tissue, characteristic of CN. (3) OCT image showing thrombotic material adjacent to the distal end of the CN causing acute occlusion. The * indicates guidewire artefact.

(0.1%) in the other study presented with STEMI.[2,4] To the best of our knowledge, only 2 previous case reports have documented the presence of a CN in the clinical setting as the precipitating cause of STEMI.[5,6] However, both of these cases occurred in unique clinical scenarios, in vessels undergoing previous revascularization, such as in-stent restenosis and coronary artery bypass graft lesion.[5,6] Clinical descriptions providing detailed diagnostic intracoronary imaging in patients with STEMI due to CNs are lacking. Our case is exceptional because it shows the capability of a CN to cause STEMI in native coronary arteries and, additionally, illustrates the unique value of OCT to unravel important diagnostic insights. Of note, OCT findings in CNs may mimic red thrombus both on angiography and OCT. This creates a "double paradox" on coronary imaging, namely a filling defect on angiography and a bright protruding mass with dorsal shadowing on OCT.[7] Because bright protruding tissue with an intense posterior shadow on OCT is a classic distinctive feature of red thrombus, a CN may be also misinterpreted as a red thrombus with this technique. This is especially relevant for the clinical scenario of STEMI, where CNs as the underlying mechanism of coronary thrombosis are exceptional. However, extensive calcification of the remaining vessel wall and the presence of a distinct borderline suggested the presence of a CN in our case. This was further confirmed by an "undilatable" tight lesion eventually requiring bailout rotational atherectomy.

It must be noted that when it comes to the identification and detailed characterization of a CN, intravascular imaging techniques are limited due to their lower resolution as compared with histological assessment. Additionally, there have been

inconsistencies with regard to the clinical definition of CNs detected by intravascular imaging in previous studies. Specifically, the debate has revolved around whether thrombus attachment is an essential criterion. In the sole study assessing in detail the morphology of CNs by histology, thrombus attachment was a prerequisite for the identification of such lesions.[8]

Interestingly, in our case, the location of the culprit lesion and the clinical comorbidities are exemplary. Previous pathological studies and recent OCT studies found the mid-RCA to be the most frequent location of CNs.[4,9] This may be due to the elevated coronary torsion stress in the RCA. Furthermore, CNs were more frequent in older patients with chronic kidney disease. Given the remarkably low incidence of CNs causing STEMI, a high degree of clinical awareness is needed to suspect and eventually confirm the diagnosis. Therefore, our case underscores the importance of OCT as a valuable tool for the diagnosis of CNs and to guide invasive treatment.[9]

FOLLOW-UP

The clinical outcome was uneventful, and the patient was discharged 7 days after admission.

CONCLUSIONS

This exceptional case of a CN in a native coronary artery causing STEMI, exemplifies the challenging diagnostic work-up of this entity, considering its rareness in this clinical setting and the potential of generating a “double paradox” on coronary imaging.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS OF CORRESPONDENCE: Dr Fernando Alfonso, Department of Cardiology, Hospital Universitario de La Princesa, Universidad Autónoma de Madrid, CIBER-CV, IIS-IP, Calle Diego de Leon 62, Madrid 28006, Spain.

REFERENCES

1. Virmani R, Burke AP, Farb A, Kolodgie FD. Pathology of the vulnerable plaque. *J Am Coll Cardiol*. 2006;47(8 Suppl):C13-C18. https://doi.org/10.1016/j.jacc.2005.10.065

2. Jia H, Abtahian F, Aguirre AD, et al. In vivo diagnosis of plaque erosion and calcified nodule in patients with acute coronary syndrome by intravascular optical coherence tomography. *J Am Coll Cardiol*. 2013;62:1748-1758.

3. Virmani R, Kolodgie FD, Burke AP, Farb A, Schwartz SM. Lessons from sudden coronary death: a comprehensive morphological classification scheme for atherosclerotic lesions. *Arterioscler Thromb Vasc Biol*. 2000;20:1262-1275.

4. Lee T, Mintz GS, Matsumura M, et al. Prevalence, predictors, and clinical presentation of a calcified nodule as assessed by optical coherence tomography. *J Am Coll Cardiol Img*. 2017;10:883-891.

5. Yumoto K, Kanaya T, Tanaka S, Fukuzawa T, Watanabe T, Aoki H. Calcified nodule as an unsolved cause of coronary stent thrombosis in the new-generation drug-eluting stent era. *Cardiovasc Interv Ther*. 2018;33:169-170.

6. Tanaka T, Yahagi K, Ninomiya K, et al. ST-segment elevation myocardial infarction related to variable calcified lesions in saphenous vein graft 33 years after coronary artery bypass grafting. *J Am Coll Cardiol Intv*. 2018;11:e181-e183.

7. Alfonso F, Rivero F, Cuesta J, Bastante T, Benedicto A. Calcified nodule: a double paradox on coronary imaging. *EuroIntervention*. 2015;11:e1-e2.

8. Torii S, Sato Y, Otsuka F, et al. Eruptive calcified nodules as a potential mechanism of acute coronary thrombosis and sudden death. *J Am Coll Cardiol*. 2021;77:1599-1611.

9. Alfonso F, Joner M. Untangling the diagnosis and clinical implications of calcified coronary nodules. *J Am Coll Cardiol Img*. 2017;10:892-896.

KEY WORDS calcified nodule, optical coherence tomography, ST-segment elevation myocardial infarction

APPENDIX For supplemental videos, please see the online version of this paper.