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CASE REPORT

BEGINNER

CLINICAL CASE

Acute Chest Pain in Duchenne Muscular Dystrophy Patient With Anomalous Coronary Artery

An Etiologic Conundrum

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ABSTRACT

A 14-year-old with Duchenne muscular dystrophy (DMD) developed chest pain with ST-segment elevation, elevated serum troponin, and progressive ventricular dysfunction. Multimodality imaging showed an anomalous right coronary artery from the left sinus of Valsalva with intramural course, but further diagnostic testing led to the diagnosis of acute presentation of DMD-associated cardiomyopathy. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2021;3:291–6) © 2021 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/).

A 14-year-old with Duchenne muscular dystrophy (DMD) presented to the emergency room for acute chest pain. He was afebrile with heart rate of 94 beats/min, blood pressure of 114/68 mm Hg, and respiratory rate of 26 breaths/min. His cardiac examination was unremarkable. An electrocardiogram showed prominent ST-segment elevation in leads II, III, aVF, and V_5 to V_6 (**Figure 1**) with initial troponin of 44 ng/ml (normal <0.02 ng/ml). Transthoracic echocardiography showed normal left ventricular (LV) size, normal LV ejection fraction (LVEF), and no regional wall motion abnormalities, but an anomalous right coronary artery origin (ARCA) from the left sinus of Valsalva was identified (Videos 1 and 2, **Figure 2**).

LEARNING OBJECTIVES

- To describe common findings in DMD-associated cardiomyopathy.
- To create a differential for children with chest pain, ST-segment changes, and troponin elevation.
- To differentiate coronary ischemia versus DMD-associated cardiomyopathy on CMR.
- To understand the benefits of each imaging modality in the clinical course of this patient.

PAST MEDICAL HISTORY

The patient had a long history of muscle weakness and was diagnosed with DMD. He was previously referred to Cardiology and had a normal echocardiogram. At time of this presentation, he could walk short distances and transfer himself from his bed.

DIFFERENTIAL DIAGNOSIS

In children presenting with ST-segment elevations and elevated troponins, viral myocardial inflammatory syndromes are most common (1). Recreational

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ABBREVIATIONS AND ACRONYMS

ARCA = anomalous right coronary artery

CMR = cardiac magnetic resonance

DMD = Duchenne muscular dystrophy

LGE = late gadolinium enhancement

LV = left ventricle

LVEF = left ventricular ejection fraction

drug intoxication, excessive beta agonists, shock, vasculitis (including Kawasaki disease), and pulmonary embolism are also seen (1). Ischemic disease related to coronary anomalies rarely present like this. DMD-associated cardiomyopathy presenting with acute chest pain is also rare.

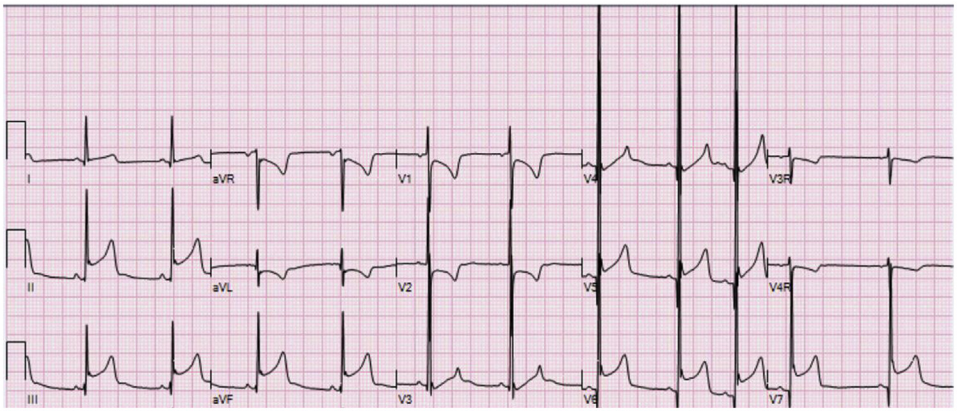
INVESTIGATIONS

Cardiac computed tomography confirmed the ARCA from the left sinus of Valsalva superior to the origin of the left main coronary artery with a long intramural course. Ostial and proximal coronary narrowing were also noted (**Figure 2**). His laboratory tests were notable for leukocytosis, normal inflammatory markers, and negative viral studies. His troponin peaked at 291 ng/ml 12 h later with a repeat transthoracic echocardiogram at that time showing decreased LVEF and regional wall motion abnormalities in the lateral segments. Strain analysis showed decreased deformation in the basolateral and LV lateral wall with early paradoxical stretching in the basolateral region. His global longitudinal strain was depressed at −7.5% (**Figure 3**, Video 3). With this clinical change, a combined catheterization and cardiac magnetic resonance (CMR) imaging was performed. The catheterization confirmed ARCA with right dominant coronary system and normal left coronary artery distribution. There were no filling defects in proximal or distal coronary arteries. His LV end diastolic pressure was severely elevated. CMR showed moderately depressed LV systolic function with ejection fraction of 30%, marked hypokinesis of the lateral LV wall, and no myocardial edema by T2-weighted imaging. There was diffuse subepicardial late gadolinium enhancement (LGE) with subendocardial sparing at the basal, mid-ventricular lateral segments, and diffuse apical segments (Videos 4 and 5, **Figure 4**).

MANAGEMENT

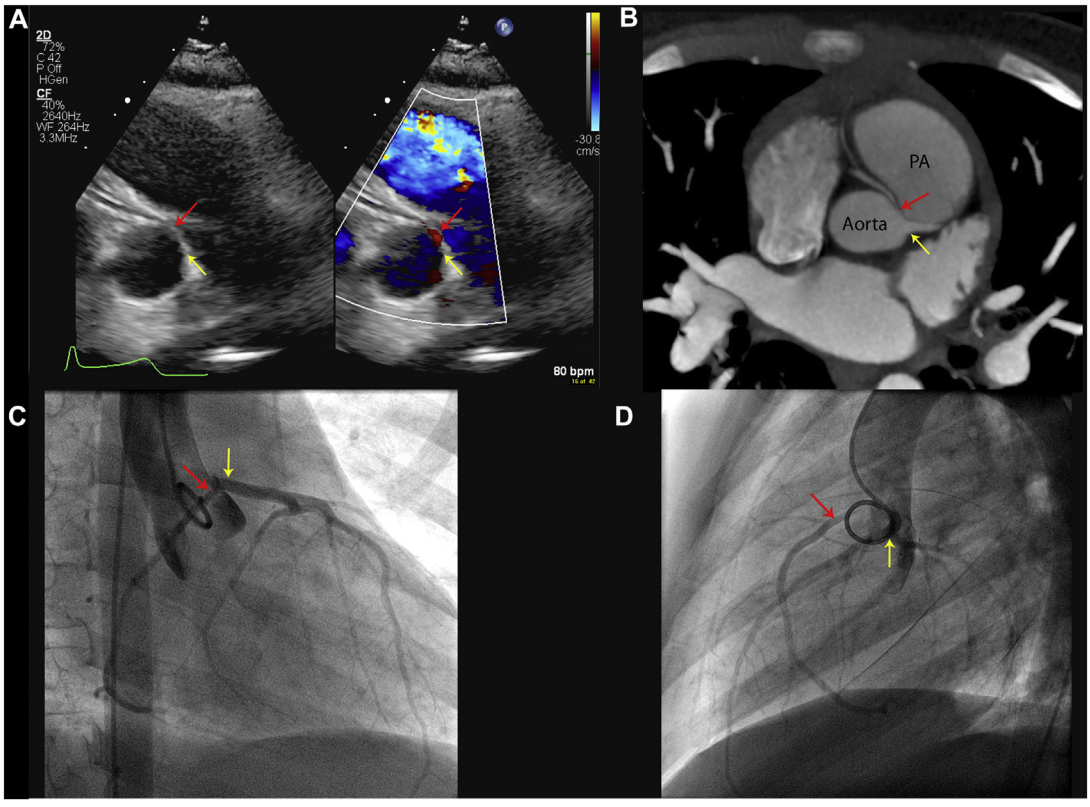
He remained mechanically ventilated post-catheterization on milrinone, diuretics, and stress dose steroids. He improved and was extubated and transitioned to lisinopril, spironolactone, and furosemide. He developed nonsustained ventricular tachycardia that was controlled with a low dose of propranolol. An echocardiogram at discharge showed mildly depressed LVEF. Strain analysis showed moderate to severe lateral and posterior wall

FIGURE 1 Electrocardiogram at Presentation



Electrocardiogram demonstrating significant ST-segment elevations in II, III, aVF, and V_5 to V_6.

FIGURE 2 **Echocardiogram and Computed Tomography Scan Images Demonstrating the Right Coronary From the Left Sinus of Valsalva**



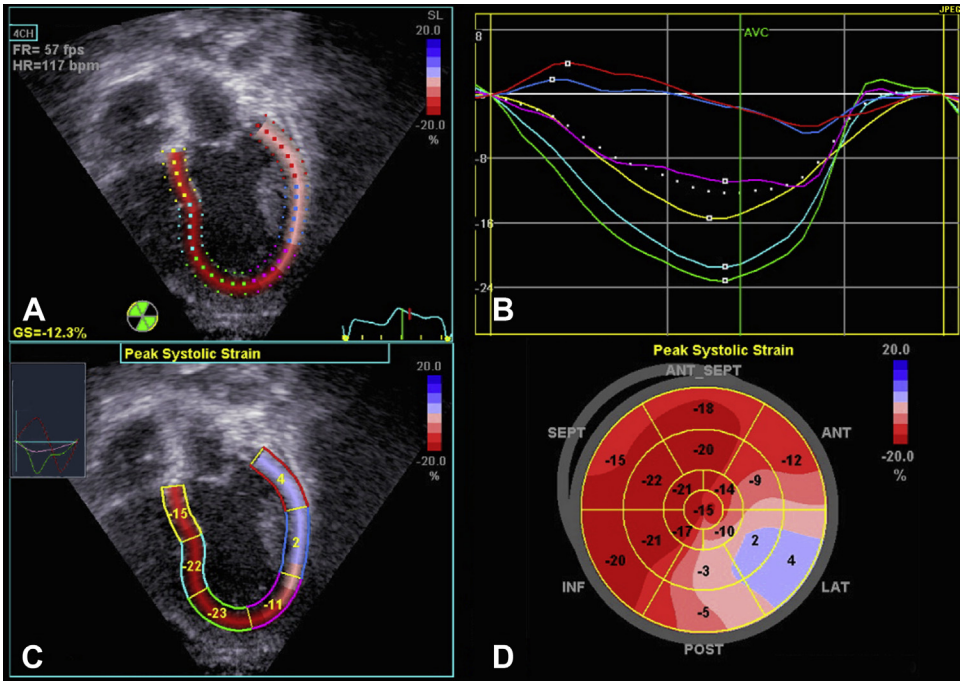
In all images, **red arrows** denote the anomalous right coronary artery, **yellow arrows** denote the left coronary artery. **(A)** Transthoracic echocardiogram color Doppler compare image of the ARCA from the left sinus of Valsalva. **(B)** Cardiac computed tomography demonstrating the anomalous right coronary artery from the left sinus of Valsalva. Note the proximal narrowing. **(C)** Right anterior oblique projection of an aortic root injection focused on the proximal coronary origins. Note the right coronary artery originating from the left sinus of Valsalva. No discrete stenoses are seen. The posterior descending artery arises from the right coronary artery for a right dominant system. **(D)** Straight lateral projection of an aortic root injection focused on the proximal coronary origins. No discrete stenoses are seen.
PA = pulmonary artery.

hypokinesis and mild anterior wall hypokinesis with improved global longitudinal strain of −12%. Before discharge, N-terminal brain natriuretic peptide was significantly elevated to 3,734 pg/ml (normal <1,100 pg/ml).

DISCUSSION

DMD is caused by a mutation in the X-linked dystrophin gene resulting in near absence of the dystrophin protein with skeletal muscle weakness as the main manifestation (2). The average age of onset of decreased LVEF is 14.3 years with more than half developing dilated cardiomyopathy by age 18 years (3–5). Glucocorticoids are known to slow the progression of weakness and cardiomyopathy (3), but cardiomyopathy is still the cause of death in nearly 30% of individuals with DMD (2). Typically, it is a slow progression, but recent reports describe acute presentations of cardiac disease in DMD. In a case series by Hor et al. (6), 8 boys were found to have ST-segment changes, elevated troponin, reduced LVEF by echocardiography, and increased LGE on magnetic resonance imaging that persisted in follow-up. This was only attributable to DMD-associated cardiomyopathy, as there were no coronary filling defects or evidence of viral myocarditis.

FIGURE 3 Initial Myocardial Strain Imaging



Transthoracic echocardiogram obtained myocardial strain images in the apical 4 chamber (A4C) view. **(A)** Automated endocardial border tracing and segmentation. **(B)** Strain curves. **(C)** Peak systolic strain for each segment. **(D)** Global longitudinal strain of the 17-segment model of the left ventricle. Note decreased deformation in the basolateral region and decreased left ventricular longitudinal strain in the left lateral ventricular wall with early paradoxical stretching in the basolateral region.

In our patient, the severity of his presentation and presence of an ARCA made the etiology of this case complex. ARCA is present in <1% of adults based on autopsy and prospective coronary angiographic studies (7). A slit-like ostial orifice, long intramural course, interarterial course, and acute angle take-off from the aorta are thought to be high-risk features of anomalous coronary arteries. (8,9). His ST-segment elevations in the inferolateral leads and CMR reflected a non-right coronary artery ischemia distribution. CMR showed hypokinesia of the lateral LV wall and subepicardial LGE in the corresponding segments and no areas of myocardial edema or subendocardial LGE. Subendocardial or transmural LGE is more characteristic of coronary ischemic changes, whereas subepicardial or intramural LGE is more characteristic of myocarditis and DMD-associated cardiomyopathy (6,10). These findings supported the diagnosis of DMD-associated cardiomyopathy and not ischemia from ARCA. Therefore, a supportive care strategy was provided instead of interventional or surgical repair of ARCA.

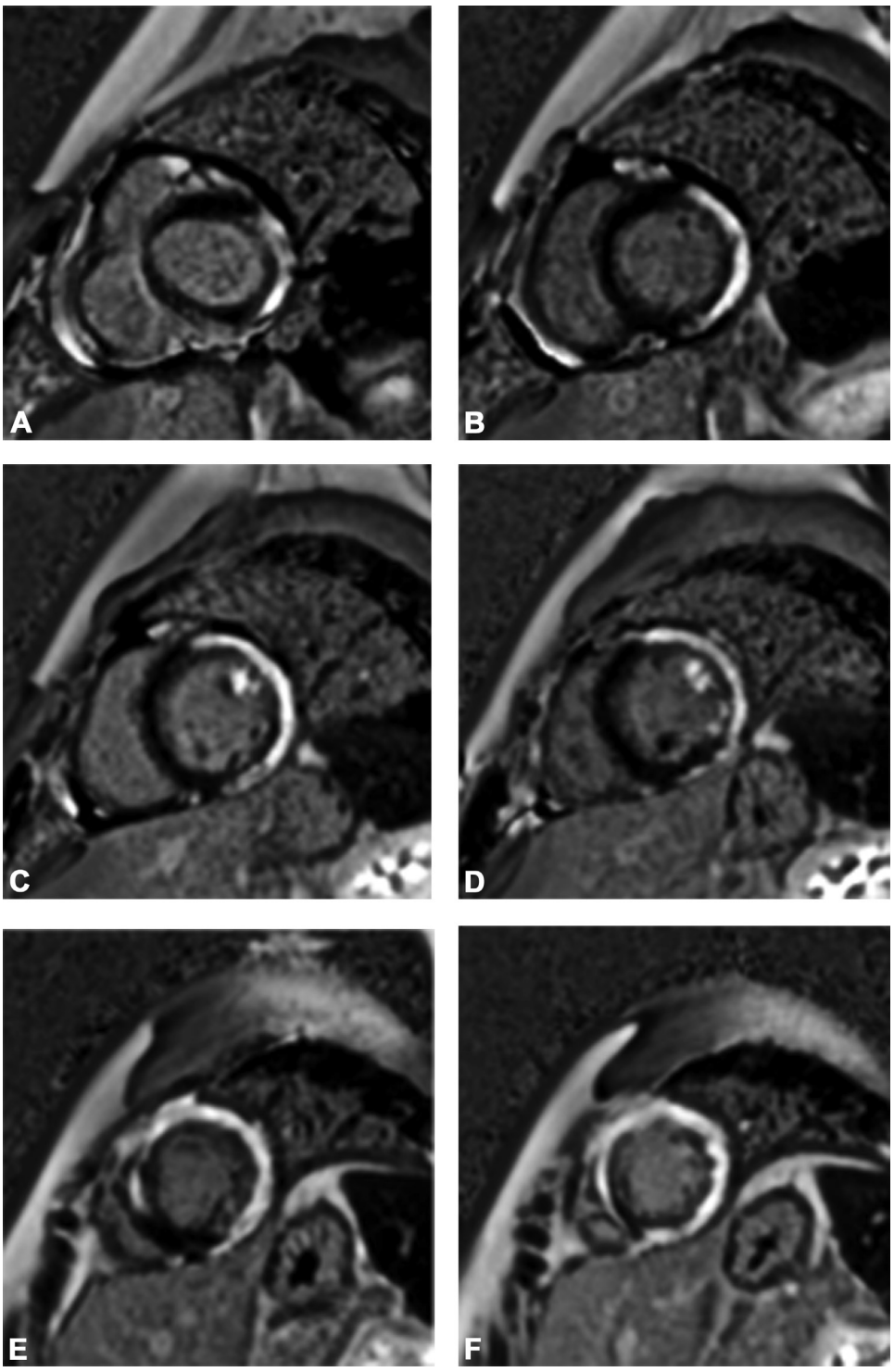
FOLLOW-UP

A follow-up CMR 5 months later showed mildly depressed LV function (LVEF 48%) with multiple areas of subepicardial LGE in a similar distribution to the initial study. His echocardiogram continues to show lower limit of normal function with an LVEF of 55%. He continues to receive lisinopril, spironolactone, propranolol, and prednisone.

CONCLUSIONS

To our knowledge, this is the first reported case of acute presentation of DMD-associated

FIGURE 4 **Cardiac Magnetic Resonance Imaging**



Cardiac magnetic resonance demonstrating late gadolinium enhancement at the basal **(A)** and mid-ventricular lateral **(B to D)** segments and diffuse apical **(E, F)** segments of the left ventricle. Note the pattern of sub-epicardial enhancement with spared subendocardium.

cardiomyopathy and an anomalous coronary artery. In this patient, multimodality imaging confirmed ARCA from the left sinus of Valsalva with intramural course, but CMR differentiated DMD-associated cardiomyopathy from coronary ischemia due to ARCA. This case illustrated challenges in diagnosis and management of acute presentation of DMD-associated cardiomyopathy, especially when other structural anomalies are present and supports the use of CMR early in the course.

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REFERENCES

1. Yoldas T, Orun U. What is the significance of elevated troponin I in children and adolescents? A diagnostic approach. Pediatr Cardiol 2019;40:1638–44.

2. Wittlieb-Weber CA, Knecht K, Villa C, et al. Risk factors for cardiac and non-cardiac causes of death in males with Duchenne muscular dystrophy. Pediatr Cardiol 2020;41:764–71.

3. Barber BJ, Andrews JG, Lu Z, et al. Oral corticosteroids and onset of cardiomyopathy in Duchenne muscular dystrophy. J Pediatr 2013;163:1080–4.

4. Connuck DM, Sleeper LA, Colan SD, et al. Pediatric Cardiomyopathy Registry Study Group. Characteristics and outcomes of cardiomyopathy in children with Duchenne or Becker muscular dystrophy: a comparative study from the Pediatric Cardiomyopathy Registry. Am Heart J 2008;155:998–1005.

5. Spurney C, Shimizu R, Morgenroth LP, et al. Cooperative International Neuromuscular Research Group Duchenne Natural History Study demonstrates insufficient diagnosis and treatment of cardiomyopathy in Duchenne muscular dystrophy. Muscle Nerve 2014;50:250–6.

6. Hor KN, Johnston P, Kinnett K, et al. Progression of Duchenne cardiomyopathy presenting with chest pain and troponin elevation. J Neuromuscul Dis 2017;4:307–14.

7. Angelini P, Velasco JA, Flamm S. Coronary anomalies: incidence, pathophysiology, and clinical relevance. Circulation 2002;10:2449–54.

8. Taylor AJ, Byers JP, Cheitlin MD, et al. Anomalous right or left coronary artery from the contralateral coronary sinus: "High-risk" abnormalities in the initial coronary artery course and heterogeneous clinical outcomes. Am Heart J 1997;133:428–35.

9. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease: executive summary. J Am Coll Cardiol 2019;139:e637–97.

10. Friedrich MG. Tissue characterization of acute myocardial infarction and myocarditis by cardiac magnetic resonance. J Am Coll Cardiol Img 2008;1:652–62.

KEY WORDS cardiomyopathy, coronary anomaly, Duchenne muscular dystrophy, myocarditis

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