Subacute Stent Thrombosis After Primary Percutaneous Coronary Intervention in a Middle-Aged Anabolic Steroid–Abusing Bodybuilder

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ABSTRACT

A 54-year-old male bodybuilder who was abusing anabolic steroids developed an acute ST-segment elevation myocardial infarction after strenuous strength training. Despite optimal use of dual antiplatelet therapy, on day 4 after primary coronary stenting, the patient suffered another acute coronary event due to subacute thrombosis, potentially predisposed by anabolic steroid use. (Level of Difficulty: Intermediate.) (J Am Coll Cardiol Case Rep 2021;3:537–41) © 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/).

LEARNING OBJECTIVES

- To consider the possibility of abuse of performance-enhancing drugs such as AAS in acute coronary events in athletes or exercise enthusiasts.
- To recognize the risk and management of subacute thrombosis after a percutaneous coronary intervention.
- To understand the side effects of AAS on the cardiovascular system.

HISTORY OF PRESENTATION

A 54-year-old male bodybuilder presented to the emergency department with an episode of acute severe substernal chest pain accompanied by nausea, which had begun after strenuous strength training at midnight and worsened during showering after training. The pain started 3 h before his arrival to the emergency department. He had no precordial angina before the acute events.

Based on the patient’s clinical presentation and the initial electrocardiogram (ECG) findings (Supplemental Figure 1A) on arrival, myocardial infarction (MI) was diagnosed. Coronary angiography on arrival revealed total occlusion at the distal portion of the right coronary artery (Figure 1A). Arterial plaque rupture and thrombus formation at the site were documented by optical coherence tomography (OCT). An everolimus-eluting stent was implanted at the site, with a significant improvement in coronary flow. Optimal stent position was confirmed in a final evaluation by OCT after...
implantation (Figure 1B). Medical treatment after admission included aspirin 100 mg/day and prasugrel 3.75 mg/day (after a loading dose of 20 mg).

On day 4 after admission, the patient again presented with chest pain. His systolic blood pressure decreased to 60 mm Hg with a heart rate of 40 beats/min and arterial oxygen saturation of 98%. On physical examination, lung and heart sounds were normal with no peripheral edema.

**MEDICAL HISTORY**

The patient reported nonmedical use of androgen and anabolic steroids (AAS), oral oxandrolone (20 mg) and methandienone (40 mg) daily. He was training systematically for a world-class bodybuilding competition and had been taking the AAS cyclically with 3 months “on” and 1 month “off” in addition to protein supplements for the last 3 years. He had restarted the “AAS-on” phase 2 months before the admission and took the AAS on the day of the acute event.

The patient underwent a private periodic health evaluation 3 months before admission. Dyslipidemia and liver dysfunction were detected by fasting blood tests as follows: low-density lipoprotein cholesterol, 150 mg/dl; high-density lipoprotein cholesterol, 32 mg/dl; triglycerides, 148 mg/dl; aspartate aminotransferase, 105 IU/l; and alanine aminotransferase, 272 IU/l. He was a nonsmoker and a social drinker. There was no history of diabetes, hypertension, cardiovascular diseases, or significant family history.

**DIFFERENTIAL DIAGNOSIS**

The differential diagnosis of chest pain occurring in a subacute phase after acute MI included cardiac free wall rupture, ventricular septal perforation, coronary spasm, or subacute stent thrombosis.

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**FIGURE 1** Right Coronary Angiography and Optical Coherence Tomography

**A** at pre-PCI on admission

**B** at post-PCI on admission

**C** at subacute thrombosis on day 4 after admission

Images of right coronary angiography (RCAG) and optical coherence tomography (OCT) at pre-percutaneous coronary intervention (PCI) on admission (A), post-PCI on admission (B), and subacute thrombosis on day 4 after admission (C). OCT images were obtained proximal (1), mid (2), and distal (3) to the sites of the culprit lesion. Stent was implanted in the lesion (1 to 3). White arrowhead indicates the site of plaque rupture. White asterisks indicate the thrombus formation.
INVESTIGATIONS

The ECG performed during the patient’s chest pain showed ST-segment elevation in the inferior leads with complete atrioventricular block (Supplemental Figure 1B). Immediate intravenous infusion of heparin and a temporary pacemaker insertion resolved his symptoms. A repeat ECG revealed a normal sinus rhythm. Emergent coronary angiography and OCT revealed a residual nonoccluding thrombus at the site of stent implantation (Figure 1C). Additional coronary angioplasty was not performed. The absence of stent malposition or coronary dissection by the stent edges was confirmed by using OCT. Blood investigations showed no abnormalities in platelet count or coagulation profile (Table 1). A VerifyNow assay (Instrumentation Laboratory, Bedford, Massachusetts) was also performed to evaluate platelet function on the day of the thrombotic event and indicated the optimal dose of dual antiplatelet therapy.

On echocardiogram, concentric left ventricular hypertrophy with a maximum wall thickness of 14 mm was noted. We thus conceived that the thrombotic events might be conferred in part by the AAS abuse. Total and free testosterone concentrations were measured in serum samples on day 7. We found low levels of total and free testosterone (Table 1). However, the patient had no clinical symptoms associated with late-onset hypogonadism. In addition, his weight and body mass index were 111.6 kg and 36.9 kg/m², respectively, with the remarkable muscular appearance (Figure 2) on admission. Because AAS are synthetic agents, ultra-fast liquid chromatography-tandem mass spectrometry was performed to detect oxandrolone and methandienone in peripheral blood, as previously described (1). For the analyte compounds obtained, the mass spectra were detected in positive-ion electrospray ionization (Supplemental Table 1). Only the presence of the oxandrolone compound was detected in the patient plasma (Figure 3). A quantitative analysis showed 0.28 ng/ml of the oxandrolone concentration.

MANAGEMENT

Despite optimal use of dual antiplatelet therapy, the patient experienced subacute stent thrombosis.

| TABLE 1 Blood Test Results |
|-----------------------------|
| **Data on Day 4**            | **Reference Range** |
| Pit number (×10⁹/µl)        | 27.3               | 14.0-37.9         |
| Mean platelet volume (fl)   | 9.8                | 8.3-11.5          |
| PT (INR)                    | 1.04               | 0.84-1.14         |
| APTT (s)                    | 29.2               | 26.0-38.0         |
| VerifyNow assay             |                    |                   |
| Aspirin reaction unit       | 466                |                   |
| P2Y12 reaction unit         | 147                |                   |
| **Data on Day 7**           |                    |                   |
| Total testosterone (ng/ml)  | 2.9                | 2.8-8.0           |
| Free testosterone (pg/ml)   | 2.2                | 4.9-19.6†         |
| Oxandrolone (ng/ml)         | 0.28               | -                 |

*Day of onset of subacute thrombosis. †Reference range for male subjects aged in their 50s. APTT = activated partial thromboplastin time; Pit = platelet; PT (INR) = prothrombin time (international normalized ratio).
recent meta-analysis (2) indicated that dual antiplatelet therapy with warfarin or direct oral anticoagulants, including apixaban, could reduce the risk of stent thrombosis. There was no difference in the efficacy between warfarin and direct oral anticoagulants. In the current case, blood examination showed liver dysfunction, which potentially disturbed the warfarin titration. We therefore decided to additionally administer a direct oral anticoagulant (apixaban 10 mg/d). Anticoagulation therapy with dual antiplatelet therapy was continued for 2 weeks, after which aspirin was stopped. Early withdrawal of aspirin might expose the patient to an increased risk of new stent thrombosis. However, the patient discontinued taking the AAS, which might lower the risk. Also, current guidelines in our country (3) propose that aspirin should be stopped within 14 days after percutaneous coronary intervention to decrease bleeding, although there is no evidence regarding the timing of aspirin discontinuation.

**DISCUSSION**

AAS are synthetic testosterone analogues and known as sports performance-enhancing drugs. High-dose or multiple AAS abuse has been associated with serious side effects, including cardiovascular adverse events such as dyslipidemia, hypertension, and cardiac...
hypertrophy (4). Although acute MI is possibly the most devastating complication, limited case reports have reported its association with abuse of AAS (5). This report is the first to describe subacute thrombosis after coronary stenting following an acute MI in a patient with abuse of AAS.

Subacute thrombosis is a rare event in the current drug-eluting stent era. In this context, subacute thrombosis occurred in the patient without an underlying thrombotic disorder despite the current recommended use of antiplatelet therapy after coronary stenting following an acute MI in the patient without an drug-eluting stent era. In this context, subacute thrombosis were caused at least in part by the thrombotic activity enhanced by AAS.

Prevention of subacute stent thrombosis remains to be explored. The approved dose of prasugrel (3.75 mg/day) in Japan is much lower than that in other countries (10 mg/day). It is not clear whether this dosage is appropriate for overweight Japanese patients. Also, optimal antithrombotic therapy to prevent the recurrence of stent thrombosis needs to be determined. The role of a VerifyNow assay seems to be limited in predicting and identifying the cause of stent thrombosis because stent thrombosis is conferred by several factors such as local coagulation activity. Further studies will be needed to address these issues.

**FOLLOW-UP**

The patient was referred to a comprehensive cardiac rehabilitation program in the rehabilitation hospital for secondary prevention and advised to discontinue use of AAS and vigorous exercise training.

**CONCLUSIONS**

This report presents a unique case of exercise-related acute MI followed by subacute thrombosis, potentially predisposed by abuse of AAS.

In senior athletes and people who exercise vigorously, coronary artery disease is the most common cause of sports-related sudden cardiac death (6). Performance-enhancing drugs such as AAS could potentially enhance cardiovascular risks. Thus, to prevent sudden cardiac events, clinicians should warn athletes about cardiovascular toxicity induced by AAS.

**ACKNOWLEDGMENTS** The authors thank Associate Prof. Xiao-pen Lee and Prof. Takaaki Matsuyama from the Department of Legal Medicine, Showa University School of Medicine, for their kind cooperation and performing ultra-fast liquid chromatography-tandem mass spectrometry to detect the AAS.

**FUNDING SUPPORT AND AUTHOR DISCLOSURES**

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

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**KEY WORDS** acute coronary syndrome, anabolic steroids, exercise, subacute thrombosis

**APPENDIX** For a supplemental figure and table, please see the online version of this paper.