Case Report

Exercise Stress Test-Induced Torsade de Pointes: A Case Report

Iswandy Janetputra Turu' Allo[1*], MD; Badai Bhatara Tiksnadi[2], MD; Chaerul Achmad[2], MD; Mira Rahmawati[1], MD

ABSTRACT

Torsade de pointes (TdP) is an infrequent, yet fatal ventricular arrhythmia as it may degenerate into sudden cardiac death. Given its lethality, it is important to understand its triggering factors and management. We report a rare case of TdP during an exercise stress test. A 64-year-old woman with controlled hypertension underwent an exercise stress test due to her atypical chest pain. She had no family history of sudden cardiac death. A baseline electrocardiogram showed an insignificant prolongation in her corrected QT (QTc) value (479 ms). During the second stage, she developed a transient TdP and was managed in the intensive care unit. A further examination showed moderate hypokalemia, and coronary angiography showed 90% to 95% stenosis in her right coronary artery. A follow-up exercise stress test after electrolyte replacement therapy and coronary revascularization showed a negative ischemic response without arrhythmia. TdP in this patient might have been related to 3 conditions: ischemic burden, hypokalemia, and exercise. Further examinations are needed to inform further management and preventive measures. ***(Iranian Heart Journal 2021; 22(4): 140-144)***

KEYWORDS: Arrhythmias, Exercise test, Hypokalemia, Ischemia, Torsade de pointes

[1] Department of Cardiology and Vascular Medicine, Cibabat General Hospital, Cimahi, Indonesia.
[2] Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital, Bandung, Indonesia.

***Corresponding Author:** Iswandy Janetputra Turu' Allo, MD; Department of Cardiology and Vascular Medicine, Cibabat General Hospital, Cimahi, Indonesia.
Email: iswandy.t.a@gmail.com **Tel:** +628112307195

Received: April 24, 2021 **Accepted:** June 17, 2021

Torsade de pointes (TdP) is an uncommon, fatal polymorphic ventricular arrhythmia with a wide variety of etiologies and triggering factors. Although the exact prevalence of TdP remains unknown, it is reported that females have a 2 to 3-fold increased frequency of TdP. [1] Among the risk factors, exercise, albeit safe for most people, might increase the possibility of arrhythmia in certain conditions. [2] The prevalence or incidence of TdP during an exercise stress test (EST), to the best of our knowledge, has never been reported and might be presumed as a rare case. In this case report, we present and discuss a patient experiencing TdP during an EST.

Case Report

A 64-year-old woman with a history of controlled hypertension came to the cardiology and vascular medicine clinic for a routine visit. The patient complained of nothing other than atypical chest pain. Her vital signs were stable, with normal blood pressure (135/80 mm Hg) and heart rate (80 beats/min). Her other physical examination findings were within the normal limit. A pretest probability evaluation indicated an

11% probability for obstructive coronary artery disease (CAD). Electrocardiography (ECG) showed a slight prolongation of the corrected QT (QTc) value based on the Bazett formula (QTc=479 ms) (Fig. 1). [3] Anamnesis confirmed that the patient was neither consuming any medication known to prolong QTc nor having any history of syncope or sudden cardiac death within her family. No electrolyte examination was conducted. As no imaging modalities were available in the center, we ran an EST (ie, treadmill exercise test/TMET) using the Bruce protocol. During the second stage of the TMET, a transient TdP that lasted for approximately 13 seconds (Fig. 2) was found, prompting us to terminate the test. Although alert, the patient experienced mild palpitations without any chest pain. Accordingly, she was immediately admitted to the intensive care unit (ICU). Her blood test showed moderate hypokalemia (K^+=2.8 mmol/L), and potassium replacement therapy was conducted using 2 cycles of potassium chloride solution 25 mEq in 500 mL of the Ringer lactate solution for 6 hours each. She received magnesium (1 g in 100 mL of D5W solution by bolus injection) and lidocaine (0.75 mg/kg/body weight by bolus injection), followed by lidocaine (1 mg/min via an intravenous drip), bisoprolol (1×2.5 mg), fenofibrate (1×100 mg), and folic acid tablets (1×1). Her potassium level (K^+=3.7 mmol/L) and her QTc (440 ms) were normal following potassium replacement. After stabilization, she was referred for coronary angiography, which revealed significant stenosis (90%–95%) at the proximal-mid part of the right coronary artery (Fig. 3). A non–drug-eluting stent (3.0×29 mm) was placed due to the unavailability of an appropriate size drug-eluting stent. No ischemic response was indicated at the follow-up EST 2 weeks later. The patient received the following medications: acetylsalicylic acid (1×80 mg), clopidogrel (1×75 mg), atorvastatin (1×40 mg), fenofibrate (1×100 mg), bisoprolol (1×2.5 mg), and ramipril (1×5 mg). She was advised to come to us for routine follow-ups.

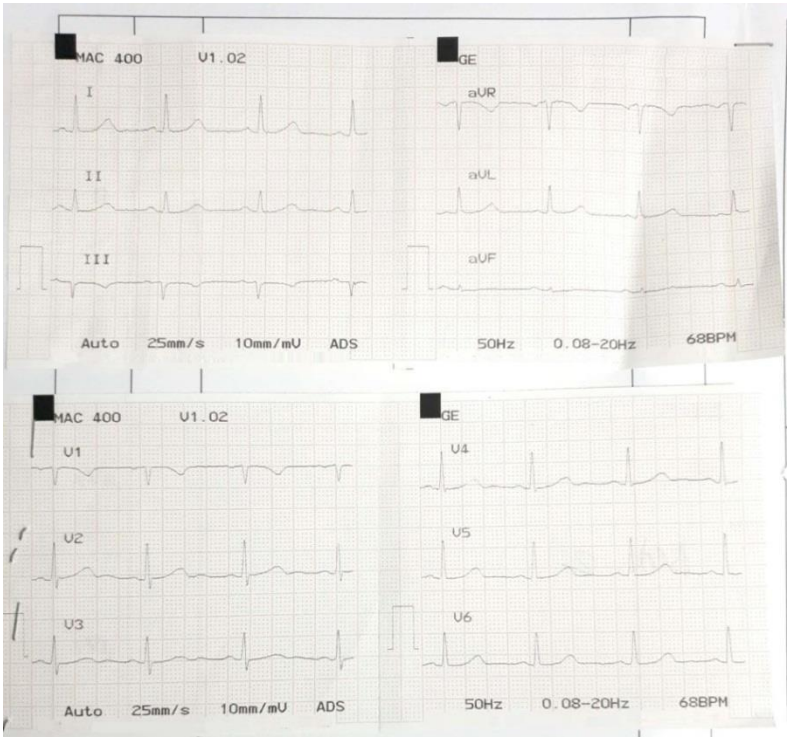

Figure 1. The electrocardiogram (ECG) taken before the exercise test shows a normal resting ECG without a prolonged corrected QT (QTc) (479 ms).

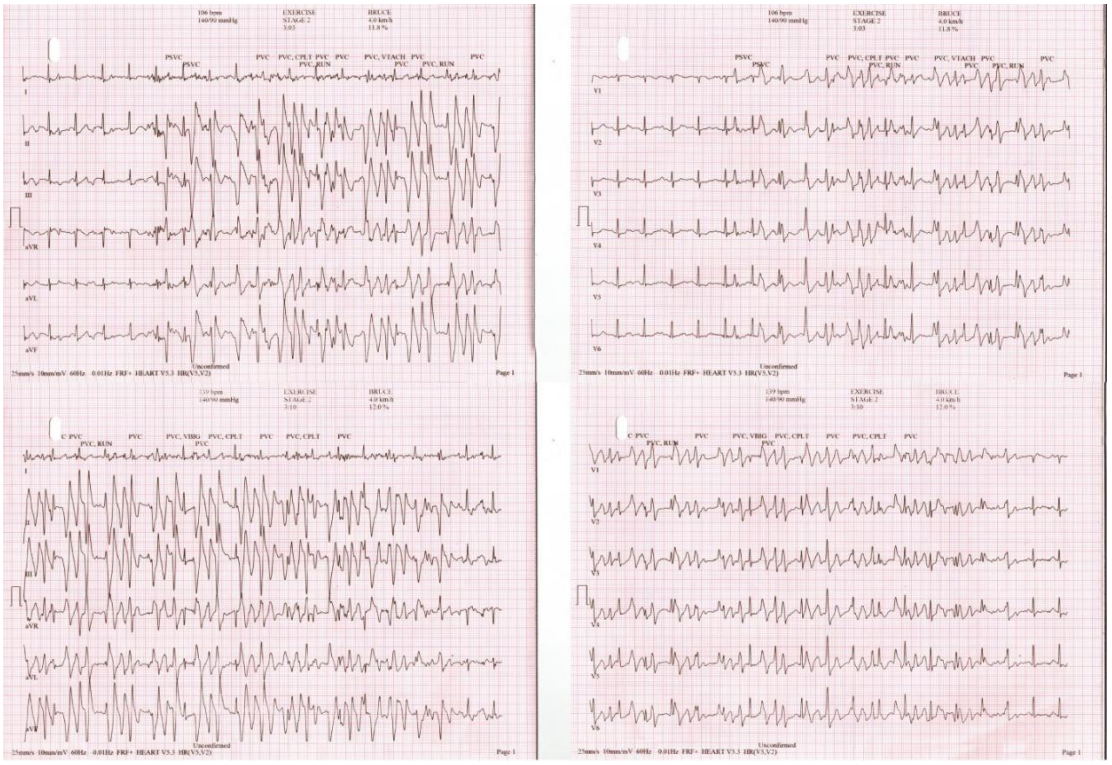

Figure 2. Transient Torsade de pointes (TdP) during the second stage of the exercise test using the Bruce protocol lasted for approximately 13 seconds.

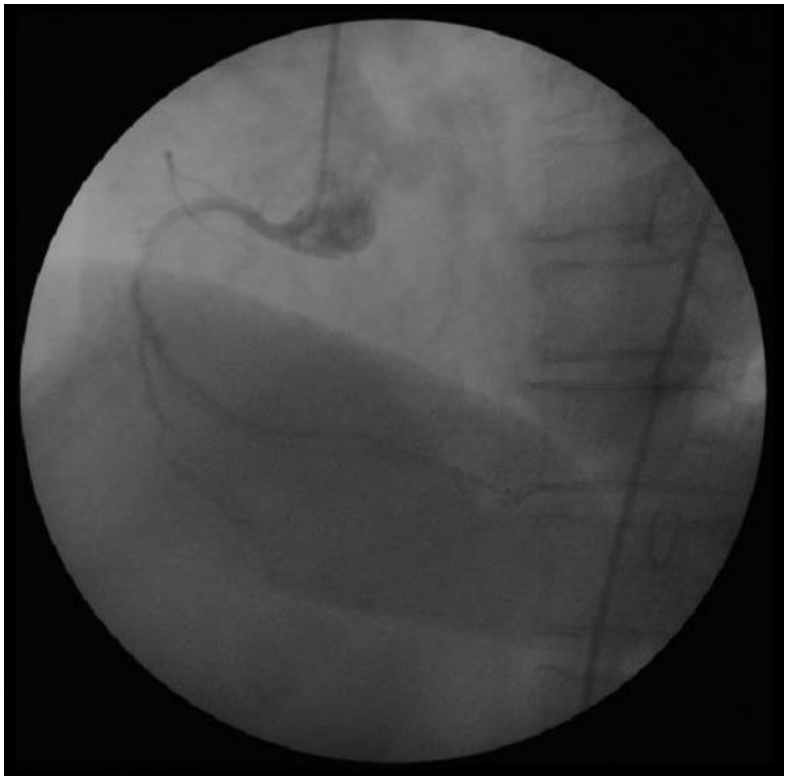

Figure 3. Coronary angiography shows significant stenosis (90%–95%) at the proximal-mid part of the right coronary artery.

DISCUSSION

TdP has been known to be fatal, and it might result in sudden cardiac death. Its causes and triggering factors extend from genetic to acquired causes. [1] Analyzing our patient, we found several possible triggering factors for her TdP; they included ischemic burden, hypokalemic condition, and exercise (ie, EST).

EST has been widely utilized to diagnose CAD despite a recommendation to limit its use only if imaging tests are unavailable. In addition, the use of EST (and other diagnostic modalities of CAD) should be based on the patient's pretest probability. [4] Concerning our case, the use of EST might have placed the patient in an ischemic condition, despite a normal ECG result. Nonetheless, her pretest probability evaluation was 11%, allowing for further CAD evaluation in consideration of her symptoms, clinical judgment, and test availability. [4]

Ischemic burden might lead to a higher risk of arrhythmia through an increase in the spatial dispersion of repolarization (increased QTc, T peak-to-end [Tpe], and Tpe/QTc ratio). [5] Even when patients are supervised by healthcare professionals, each patient's response to EST may be different. Indeed, in some individuals, EST might raise the risk of arrhythmia.

Looking at the topic from another perspective, the low availability of imaging modalities for diagnosing CAD, as well as experts capable of analyzing their results, is an apparent obstacle in Indonesia, leading to the limited utilization of such modalities. In our case, the use of EST was, arguably, indicated due to the unavailability of imaging modalities. [4] This case might become an awakening reason for the government or related institutions to consistently provide and develop medical equipment in Indonesia with a view to not only reducing the possible risk in any medical examination and management but also improving the health of the Indonesian population.

Another important possible cause of TdP in our patient was her hypokalemic condition. [1] The patient was in moderate hypokalemic condition; however, it was only detected after the patient was admitted to the ICU. As is widely known, electrolyte imbalance alone might increase the possibility of arrhythmia. Our patient's potential to develop arrhythmia increased as the patient underwent EST. Coupled with CAD and hypokalemia, exercise triggered the TdP in our patient. During exercise, catecholamine activity is capable of altering extracellular potassium levels and thus electrical stability of the heart. The production of potassium by skeletal muscles during exercise will cause hyperkalemia and provoke catecholamine activity, alter extracellular potassium levels, and lead to post-exercise hypokalemia and instability of the heart's electrical conduction. [6] Therefore, a non-clinically manifested hypokalemia might still provoke cardiac arrhythmia, including TdP, in EST and/or other exercise settings. Nevertheless, pre-EST mild-to-moderate hypokalemia might be safe, [7] although we need to be cautious when a baseline potassium level is low before EST. A pre-EST electrolyte examination might be essential to prevent cardiac arrhythmia when CAD is in doubt as its combination with hypokalemia might increase the possibility of cardiac arrhythmia during EST.

Our patient's baseline ECG showed a slightly prolonged QT interval. A prolonged QT interval indicates a prolonged action potential duration, which might induce early afterdepolarization and eventually TdP. For each 10- millisecond increase in QTc, there is roughly a 5% to 7% increase in TdP occurrence. In our patient, a slightly prolonged QTc (479 ms) was found in the resting ECG. Still, the test was continued because the prolongation was insignificant (<500 ms). [3] Although a risk factor for TdP, a slightly prolonged QTc might not be a contraindication for EST. In fact, in certain

conditions, EST might help the diagnosis of long QT syndrome.[8]

A long QT interval might be caused by a genetic predisposition or an acquired condition. Our patient denied consuming any medication known to prolong QT intervals. There was also a presumption that our patient, in addition to her hypokalemia condition, had a genetic determinant for long QT syndrome. However, we considered this hypothesis as a last possibility given the patient's normal QTc after potassium replacement, and we assumed that TdP in our patient was an aftermath of the interlinked ischemia, hypokalemia, and exercise (ie, EST). Nonetheless, every possible explanation is worth exploring to understand the patient's condition better and, thus, direct the medication.

In conclusion, our case shows TdP during EST. The TdP in our case might have been triggered by a prolonged QT interval due to hypokalemia, which was exaggerated by ischemic burden and EST. Close monitoring during EST, electrolyte correction, if needed, and immediate percutaneous coronary intervention might prevent fatal consequences. The patient's baseline condition should always be a consideration to avoid a dreadful consequence, including the patient's electrolyte status pre-EST. Further diagnostic efforts are required to ensure the patient's exact cause of TdP for further management.

Acknowledgments

We thank the Department of Cardiology and Vascular Medicine, Cibabat General Hospital, Cimahi, Indonesia. This article (in an abstract format) was presented as a poster presentation at the Annual Scientific Meeting of the Indonesian Heart Association (ASMIHA) 2020.

Conflict of Interest

The authors declare that there are no conflicts of interest.

REFERENCES

1. Sauer AJ, Newton-Cheh C. Clinical and Genetic Determinants of Torsade de Pointes Risk. Circulation. 2012; 125(13):1684-94.

2. Guasch E, Mont L. Diagnosis, pathophysiology, and management of exercise-induced arrhythmias. Nat Rev Cardiol. 2017; 14(2):88-101.

3. Trinkley KE, Page RLn, Lien H, Yamanouye K, Tisdale JE. QT interval prolongation and the risk of torsades de pointes: essentials for clinicians. Curr Med Res Opin. 2013; 29(12):1719-26.

4. Knuuti J, Wijns W, Saraste A, Capodanno D, Barbato E, Funck-Brentano C, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J. 2020; 41(3):407-77.

5. Korantzopoulos P, Letsas KP, Christogiannis Z, Kalantzi K, Massis I, Milionis HJ, et al. Exercise-induced repolarization changes in patients with stable coronary artery disease. Am J Cardiol. 2011; 107(1):37-40.

6. Skogestad J, Aronsen JM. Hypokalemia-Induced Arrhythmias and Heart Failure: New Insights and Implications for Therapy. Front Physiol. 2018; 9:Article 1500.

7. Modesto KM, Møller JE, Freeman WK, Shub C, Bailey KR, Pellikka PA. Safety of exercise stress testing in patients with abnormal concentrations of serum potassium. Am J Cardiol. 2006; 97(8):1247-9.

8. Takenaka K, Ai T, Shimizu W, Kobori A, Ninomiya T, Otani H, et al. Exercise stress test amplifies genotype-phenotype correlation in the LQT1 and LQT2 forms of the long-QT syndrome. Circulation. 2003; 107(6):838-44.