JACC: CASE REPORTS VOL. 23, 2023

CASE REPORT

ADVANCED

CLINICAL CASE

Pseudo 2:1 AV Block From Acquired Long QT Syndrome From Eating Clay

Kabo Mojela, MBCHB, MMED, Philasande Mkoko, MBCHB, MMED, MPHIL, Cert Cardio, ECES

ABSTRACT

Age-related degeneration of the cardiac conduction system is an important cause of heart block and a leading indication for permanent pacemaker implantations. However, variations in the myocardial refractory periods from QT interval prolongation or concealed atrioventricular node penetration from premature ventricular complexes can lead to unusual forms of conduction block not requiring permanent pacemaker implantation. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2023;23:102018) © 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

A previously well 43-year-old woman presented with a 1-week of dizziness and presyncope. She had been taking metoclopramide 10 mg for occasional nausea and eating clay thrice weekly. Her clinical examination was unremarkable.

INVESTIGATIONS

Electrocardiogram (**Figure 1**) that was done on arrival to the emergency department showed a regular QRS interval at a rate of 48 waves/min, RR interval of 1,292 milliseconds, a QRS complex width of 108 milliseconds, negative 50° axis, an uncorrected QT interval of 833 millisecond, and QTc interval of 745 millisecond by the Bazett formula, and there is nonspecific diffuse T-wave inversion. The P waves are sinus with a P-wave rate of 96 per minute and a PP interval of 733 milliseconds, which is a 2:1 atrioventricular (AV) conduction; the conducted P-wave has an associated PR interval of 200 milliseconds.

Her laboratory results showed normal renal function and thyroid function but hypokalemia with a serum potassium of 2.7 mEq/L. Hypokalemia and metoclopramide contributed to the prolonged QT interval.

LEARNING OBJECTIVES

- Clay ingestion is a rare but important cause of severe hypokalemia.
- A severely prolonged QT interval is a cause of a pseudo 2:1 AV block when the PP interval is shorter than the QT interval.
- To identify causes of acquired long QT interval

DIFFERENTIAL DIAGNOSES

The differential diagnoses included long QT syndrome, an acquired long QT syndrome from a combination of hypokalemia induced by clay ingestion and metoclopramide. Furthermore, regarding the heart block, we considered congenital heart block,

From the Cardiac Clinic, Charlotte Maxeke Johannesburg Academic Hospital, Pacing and Electrophysiology Laboratory, Division of Cardiology, Department of Internal Medicine, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa.

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 July 4, 2023; revised manuscript received August 3, 2023, accepted August 15, 2023.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2023.102018

ABBREVIATIONS AND ACRONYMS

AV = atrioventricular

early degenerative heart block ,and infiltrative diseases such as cardiac sarcoidosis or prior myocarditis.

MANAGEMENT

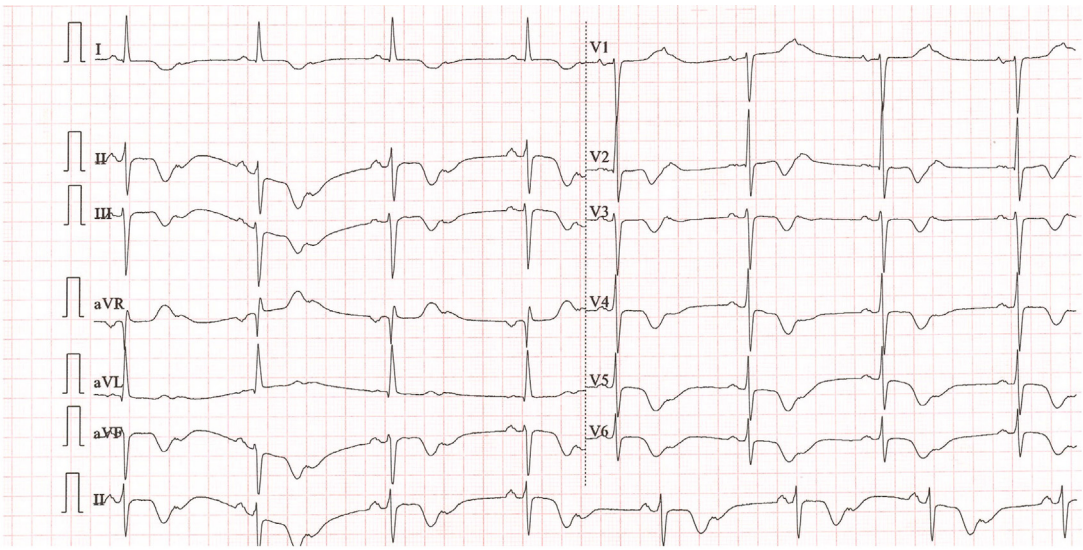
Because of the severely prolonged QT interval, a PP interval (733 milliseconds) shorter than the QT interval (833 milliseconds), we were convinced that the AV block was physiologically secondary to the prolonged QT interval and that there was no indication for pacemaker implantation (**Figure 2**). **Figure 3** demonstrates that when the PP interval prolongs, there is conduction of all the P waves. Correction of the potassium levels to 4 mmol/L and higher resulted in the correction of the QT interval and normalization of conduction. She was advised against clay ingestion as this was the potential cause of her hypokalemia.

DISCUSSION

Degenerative fibrosis and sclerosis of the AV node is the most common cause of heart block in adults.[1,2] For example, among a prospective cohort of more than half a million UK residents, the prevalence of conduction system disease (which included all levels of AV block, as well as bundle branch blocks) was approximately 11 per 10,000 persons under age 55 years and increased to between 55 per 10,000 persons ≥65 years of age.[3] Indeed, degenerative AV block is the leading indication for permanent pacemaker implantation in both low- to middle-income countries and high-income countries.[4] However, infiltrative cardiac diseases such as cardiac sarcoidosis or metabolic abnormalities can occasionally lead to variable degrees of AV block in younger patients.[1,2,5]

Electrocardiographic QT interval prolongation is a surrogate marker of a prolonged ventricular action potential duration. This increase in action potential duration can predispose to life-threatening ventricular arrhythmias such as torsade de pointes.[6] Acquired long QT syndrome is action potential duration prolongation from QT-prolonging drugs and or electrolyte imbalances. The incidence of acquired long QT syndrome is unknown. However, acquired long QT syndrome is more prevalent than congenital long QT syndrome. For example, in a retrospective study including 41,649 hospitalized patients, up 0.7% had a QTc interval >500

FIGURE 1 Presentation Electrocardiogram

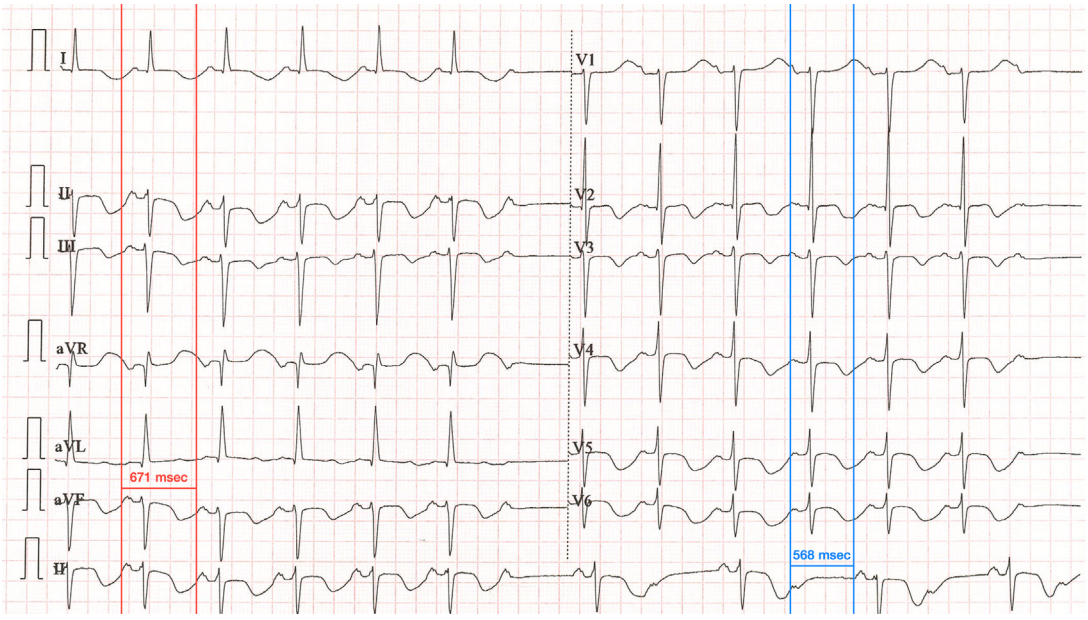


Admission electrocardiogram demonstrating what looks like 2:1 atrioventricular block, normal QRS width, left axis deviation from a left anterior fascicular block, a severely prolonged QT interval, and nonspecific T-wave inversion.

FIGURE 2 **The Relationship of the PP Interval to the QT Interval During the Apparent 2:1 AV Block**

(A) PP interval shorter than the QT interval. **(B)** The relation of the nonconducted P-wave to the ventricular myocardial action potential and the refractory period. The non conducted P wave reaches the ventricular myocardium during the refractory period, thus does not result in ventricular myocardial depolarization.

FIGURE 3 Change in PP Interval and Conduction of All P Waves



Prolongation of the PP interval to an interval longer than the QT interval results in conduction of all the P waves (red calipers). Conversely, shortening of the PP interval relative to the QT interval results in a 2:1 block (blue calipers).

milliseconds.[7] Furthermore, in another study, at least 46% of hospitalized patients who suffer from torsade de pointes had acquired long QT syndrome.[8] Most patients with acquired long QT syndrome have a combination of risk factors. For example, Zeltser et al[9] demonstrated that 71% of patients with acquired long QT syndrome had 2 or more risk factors. These included female sex, hypokalemia, heart disease, concurrent use of QT-prolonging drugs, excessive drug dose, and family history of long QT syndrome.[9] The index patient had at least 3 risk factors: female sex, hypokalemia, and use of a QT-prolonging drug (metoclopramide).

TABLE 1 Laboratory Results and QT/QTc Intervals

Results	February 24, 2023	February 24, 2023	February 27, 2023	April 17, 2023	May 15, 2023	June 12, 2023
Sodium, mmol/L	148	148	139	136	143	144
Potassium, mEq/L	2.7	3.0	4.2	4.5	4.7	4.0
Urea, mmol/L	2.3	3.2	6.2	3.1	3.5	2.6
Creatinine, μmol/L	65	72	74	6.5	73	69
Calcium, mmol/L	2.3	2.31	2.29	2.34	2.33	2.31
QTuc, ms	833	825	468	453	416	458
QTc, ms	713	706	440	449	430	442
Heart rate, beats/min	44	43	68	59	64	56

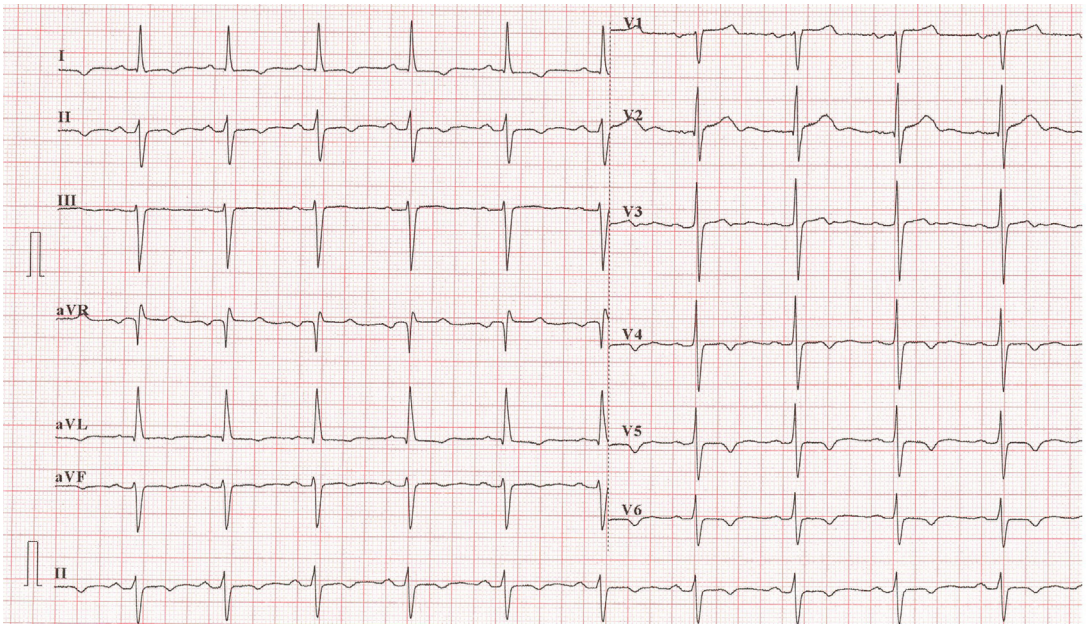
QTuc = uncorrected QT interval.

The most feared complication of a long QT interval is torsade de pointes.[10] However, a pseudo 2:1 AV block can occur in instances of severely prolonged QT interval, whereby the QT interval is longer than the PP interval, and every other P-wave comes in during or before the T-wave.[11] As such, these P waves conduct down the His-Purkinje system, and the impulse reaches the ventricular myocardium during the absolute refractory period.[11] This is typically a manifestation of congenital long QT syndrome.[12]

FOLLOW-UP

On follow-up, her potassium levels have stayed above 4 mEq/L, normal QT/QTc interval on a 12-lead electrocardiogram, and no heart block (**Table 1**, **Figure 4**).

FIGURE 4 **Follow-Up Electrocardiogram**



Follow-up electrocardiogram on correction of serum potassium to >4 mEq/L shows shortening of the QT and QTc intervals and conduction of all P waves.

CONCLUSIONS

Careful electrocardiogram analysis helped avoid unnecessary implantation of a permanent pacemaker.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

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

ADDRESS FOR CORRESPONDENCE: Dr Philasande Mkoko, Charlotte Maxeke Johannesburg Academic Hospital, Blue Block, Area 566, Pacing and Electrophysiology Laboratory, Division of Cardiology, Department of Internal Medicine, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg 2193, South Africa. E-mail: philasande.mkoko@wits.ac.za.

REFERENCES

1. Kusumoto FM, Schoenfeld MH, Barrett C, et al. 2018 ACC/AHA/HRS guideline on the evaluation and management of patients with bradycardia and cardiac conduction delay: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. *J Am Coll Cardiol*. 2019;74(7):e51-e156. https://doi.org/10.1016/j.jacc.2018.10.044

2. Glikson M, Nielsen JC, Kronborg MB, et al. 2021 ESC guidelines on cardiac pacing and cardiac resynchronization therapy. *Eur Heart J*. 2021;42(35):3427-3520. https://doi.org/10.1093/eurheartj/ehab364

3. Khurshid S, Choi SH, Weng L-C, et al. Frequency of cardiac rhythm abnormalities in a half million adults. *Circ Arrhythm Electrophysiol*. 2018;11(7):e006273. https://doi.org/10.1161/CIRCEP.118.006273

4. Bradshaw PJ, Stobie P, Knuiman MW, et al. Trends in the incidence and prevalence of cardiac pacemaker insertions in an ageing population. *Open Heart*. 2014;1(1):e000177. https://doi.org/10.1136/openhrt-2014-000177

5. Mkoko P, Rajoo ST, Chin A. Causes of heart block in young and middle-aged South Africans. *Curr Probl Cardiol*. 2022;48(8):101247. https://doi.org/10.1016/j.cpcardiol.2022.101247

6. El-Sherif N, Turitto G, Boutjdir M. Acquired long QT syndrome and electrophysiology of torsade de pointes. *Arrhythm Electrophysiol Rev*. 2019;8(2):122-130. https://doi.org/10.15420/aer.2019.8.3

7. Yu H, Zhang L, Liu J, et al. Acquired long QT syndrome in hospitalized patients. *Heart Rhythm*. 2017;14(7):974-978. https://doi.org/10.1016/j.hrthm.2017.03.014

8. Vandael E, Vandenberk B, Vandenberghe J, et al. Incidence of torsade de pointes in a tertiary hospital population. *Int J Cardiol*. 2017;243:511-515. https://doi.org/10.1016/j.ijcard.2017.05.072

9. Zeltser D, Justo D, Halkin A, et al. Torsade de pointes due to noncardiac drugs: most patients have easily identifiable risk factors. *Medicine*. 2003;82(4):282-290. https://doi.org/10.1097/01.md.0000085057.63483.9b

10. Drew BJ, Ackerman MJ, Funk M, et al. Prevention of torsade de pointes in hospital settings. *Circulation*. 2010;121(8):1047-1060. https://doi.org/10.1161/CIRCULATIONAHA.109.192704

11. Rosenbaum MB, Acunzo RS. Pseudo 2:1 atrioventricular block and T wave alternans in the long QT syndromes. *J Am Coll Cardiol*. 1991;18(5):1363-1366. https://doi.org/10.1016/0735-1097(91)90560-V

12. Weintraub RG, Gow RM, Wilkinson JL. The congenital long QT syndromes in childhood. *J Am Coll Cardiol*. 1990;16(3):674-680. https://doi.org/10.1016/0735-1097(90)90359-W

KEY WORDS **acquired long QT interval, heart block, hypokalemia, pseudo 2:1 AV block**