ONLINE ONLY

CLINICAL MEDICINE

ECG Diagnosis: The Effect of Ionized Serum Calcium Levels on Electrocardiogram

Jonathan D Gardner, MD; Joe B Calkins, Jr, MD, FACC, FACP, FASE; Glen E Garrison, MD, FACC

Perm J 2014 Winter;18(1):e119-e120

http://dx.doi.org/10.7812/TPP/13-025

Abstract

High and low levels of ionized serum calcium concentration can produce characteristic changes on the electrocardiogram. These changes are almost entirely limited to the duration of the ST segment, with no change in the QRS complexes or T waves. High ionized serum calcium shortens the ST segment, and low ionized serum calcium prolongs the ST segment. Two common clinical scenarios are presented.

Case 1 – Hypocalcemia

A 17-year-old woman with severe chronic renal failure and atrophic kidneys had an electrocardiogram (ECG) (Figure 1) with a prolonged QT interval of 0.44 seconds and a corrected QT interval (QTc) of 0.533 seconds. Her total serum calcium was 5.0 mg/dL (normal 8.6-10.6 mg/dL). Repeat analysis showed a total serum calcium of 5.8 mg/dL and an ionized serum calcium of 2.73 mg/dL (normal 4.73-5.21 mg/dL).

Case 2 – Hypercalcemia

A 37-year-old man previously had 6 kidney stones, which either spontaneously passed or were surgically removed. His preoperative ECG before surgical repair of an uncomplicated inguinal hernia had an abnormally short QT interval of 0.320 seconds and a QTc of 0.341 seconds (Figure 2). His total serum calcium was 12.0 mg/dL (normal 8.6-10.6 mg/dL), and his ionized serum calcium was 6.64 mg/dL (normal 4.73-5.21 mg/dL). This patient had primary hyperparathyroidism and had surgical removal of the parathyroid adenoma followed promptly by a rapid decrease in his serum calcium.

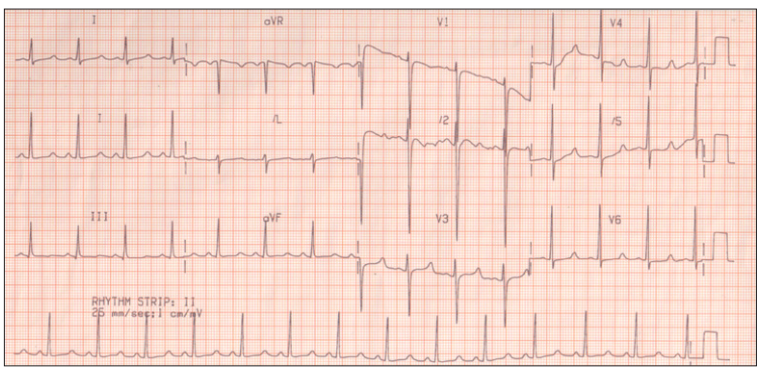

Figure 1. Electrocardiogram demonstrates prolonged QTc and QT segment in a patient with hypocalcemia.

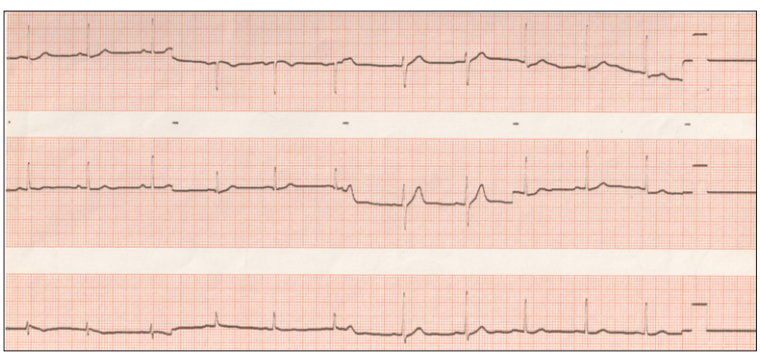

Figure 2. Electrocardiogram demonstrates shortened QTc and QT segment in a patient with hypercalcemia.

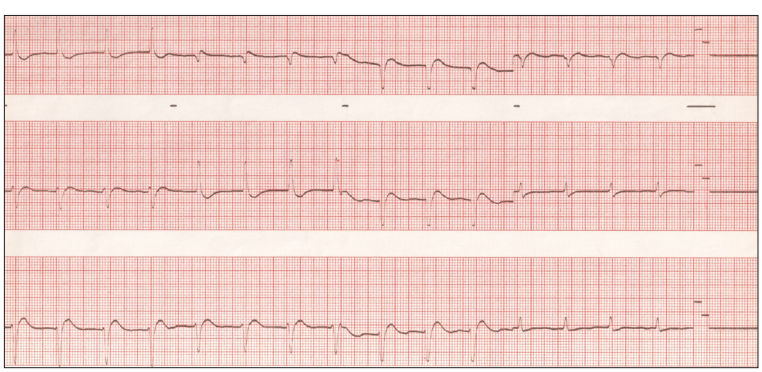

Figure 3. Electrocardiogram demonstrates the absence of an ST segment in a 59-year-old woman with marked elevation in ionized serum calcium secondary to chronic and severe hyperparathyroidism. The T wave starts immediately at the end of the QRS complex.

Jonathan D Gardner, MD, is a Chief Resident of Internal Medicine at Georgia Regents University: Medical College of Georgia in Augusta. E-mail: jongardner@gru.edu. **Joe B Calkins, Jr, MD, FACC, FACP, FASE,** is a Clinical Associate Professor of Medicine in the Section of Cardiology at the Charlie Norwood VA Medical Center and Georgia Regents University: Medical College of Georgia in Augusta. E-mail: joe.calkins2@va.gov. **Glen E Garrison, MD, FACC,** is a Clinical Professor of Medicine in the Section of Cardiology at the Charlie Norwood VA Medical Center and Georgia Regents University: Medical College of Georgia in Augusta. E-mail: glen.garrison@va.gov.

Discussion

Variations in the ionized serum calcium concentration produce the characteristic ECG changes that occur with hypercalcemia and hypocalcemia.[1,2] These changes are almost entirely limited to the duration of the ST segment with no change in the QRS complexes or T waves. High levels of ionized serum calcium shorten the ST segment on the ECG. Conversely, low levels of ionized serum calcium prolong the ST segment. Variations in the QT interval and the QTc duration are caused by variations in the duration of the ST segment.[1,2] In marked elevation of the ionized serum calcium, no ST segment is present and the T wave starts immediately at the end of the QRS complex (Figure 3).

Bazett's Formula (Figure 4) is used to calculate the QTc. A QTc greater than 500 milliseconds is associated with an increased risk for developing life-threatening cardiac arrhythmias. ❖

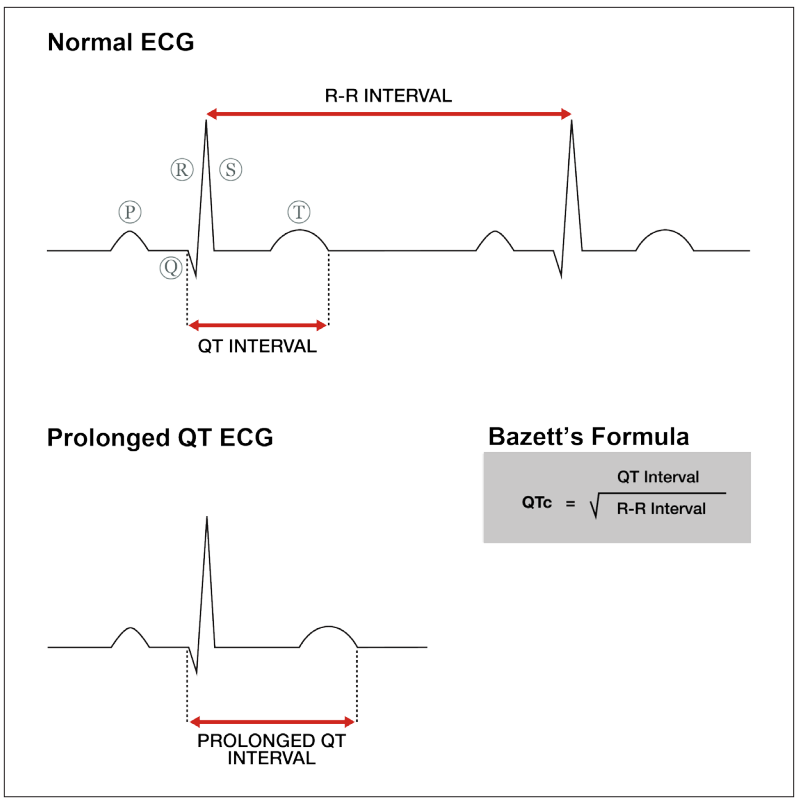

Figure 4. Comparison of a normal ST segment and QT interval with a prolonged ST segment and QT interval. Bazett's Formula is used to calculate the corrected QT interval (QTc).

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

Acknowledgment

We would like to thank Sandra Wilson, Graphic Designer and Illustrator, for designing Figure 4.

References

1. Surawicz B, Knilans TK . Chou's electrocardiography in clinical practice. 6th ed. Philadelphia, PA: Saunders Elsevier; 2008. p 543-6.
2. Wagner GS. Marriot's practical electrocardiography. 10th ed. Philadelphia: Lippincott Williams and Wilkins; 2001. p 62-3, 226-8.