

Title: Wellen's Syndrome or Inverted U Waves, a Serious Clinical Condition Needing Immediate Attention Regardless of Symptoms

Authors:

Yeo Lee, MD, 1 Mohammad Reza Habibzadeh, MD, 2 Mohammad Reza Movahed, MD, 3,4

1 CareMore, 2 Carondelet Medical Group, 3 University of Arizona, Tucson, 4 University of Arizona, Phoenix

Correspondent:

Mohammad Reza Movahed, MD, PhD, FACP, FACC, FSCAI

Clinical Professor of Medicine

University of Arizona Sarver Heart Center

1501 N Campbell Avenue, Tucson, AZ 85710

Tel: 949 400 0091

Emails: rmoval@aol.com

Any authors financial relationships or conflicts of interest regarding the content herein: None

Founding Source: None

All authors had access to the data and a role in writing the manuscript.

Key words: Wellen; Wellen's syndrome; inverted U wave; coronary artery disease; acute coronary syndrome; left anterior descending artery disease; acute anterior myocardial infarction

Presentation: 76-year-old female with hypertension, diabetes, and end stage renal disease on hemodialysis was sent to the emergency department for complaining of neck and jaw pain associated with hypotension during dialysis. Her electrocardiogram is shown in figure 1. Clearly, biphasic T waves can be seen in V2-V3. These T wave changes were not seen in her last EKG. (figure 2). She was asymptomatic in the emergency department and her troponins were negative. Her electrolytes were also within normal limits with normal vital signs. Her cardiovascular exam was unremarkable.

Assessment: The patient remained asymptomatic in the emergency room with persistent negative troponins. However, the appearance of pericardial biphasic T waves in V2 and V3 seen on her presenting EKG was consistent with Type A Wellen's syndrome EKG (or initially described by Dr. Gerson as inverted U waves). Even though, she had no chest pain and was hemodynamically stable, the classic appearance of Wellen's syndrome EKG is of major concern needing immediate diagnosis and treatment.

Diagnosis: Patients presenting with Wellen's syndrome EKGs are at a very high risk for anterior myocardial infarction requiring an invasive work up regardless of their hemodynamic stability or level of cardiac enzymes. They have usually high-grade proximal left anterior descending or left main coronary artery disease.

Management: As she was at a very high risk for myocardial infarction based on her EKG, she was taken to the cardiac catheterization laboratory despite remaining asymptomatic in the

emergency department and having normal cardiac enzymes. Her coronary angiogram showed severe three vessel coronary artery disease with involvement of her proximal left anterior descending artery as suspected (figure 3). She underwent successful coronary artery bypass grafting. After her surgery, she did well and did not experience any further episodes of hypotension or jaw pain during her dialysis.

In 1979, Gerson et. al reported exercise induced inverted terminal T waves in the pericardial leads in patients who later found to have left anterior descending artery disease. [1] It was described as an exercise induced- U wave inversion. This nomenclature was not correct as this EKG abnormality appears to involve the terminal portion of T waves and not U waves. Ninety two percent of patients with this abnormality had significant stenosis in the proximal left anterior descending artery. A year later, Gerson et al. once again, described this abnormality in resting EKGs in over 89% of patients with documented left anterior descending artery disease [2] Interestingly, two years later in 1982, de Zwaan and Wellen et al. described the same EKG abnormality [3,4] in patients with unstable angina who were found to be at a very high risk for anterior myocardial infarction. Eighteen percent of patients with unstable angina showed this ECG pattern. In patients who did not undergo coronary revascularization, 75% developed extensive anterior myocardial infarction. In 1989, Wellen and colleagues published another manuscript that also found isolated T wave inversions in V2-V3 as a major risk for left anterior descending artery ischemia. This EKG pattern of deep and symmetrical T-wave inversions in V2 and V3 is now recognized as type B Wellen's syndrome EKG. (5-7) These EKG abnormalities as an imminent risk for anterior myocardial infarction have been confirmed and recognized by many clinicians and mostly reported as Wellens' syndrome or Wellens syndrome. [4-13] This

nomenclature has gained popularity even though it was first described by Dr. Gerson . There are still many publications that uses Dr. Gerson description of this EKG abnormality and mention this abnormality exclusively as inverted U waves. [14-17] The reason for this EKG pattern is not fully understood but is thought to be related to ischemia involving septal branches of the left anterior descending artery leading to T wave changes in V2 and V3.

Despite being the same entity, available literatures continue to use these two different terminologies for the same EKG findings [18-20] and most of the authors appear to be unaware that these two nomenclatures are describing the same disease. This general unawareness in the medical community has persisted despite a paper that was published in 2008 addressing this confusion and dilemma. [21] Hopefully with this case report, we can improve awareness of the medical community about this important issue. Type A occurs approximately in 25% and type B in 75% of patients with Wellens' syndrome. (6,7) It is important to be aware that there are many other causes of T waves inversions that are not related to the left anterior descending artery ischemia. (24) Usually, clinical presentation and other EKG features can help to avoid misdiagnosis. Other criteria for diagnosing of Wellens' syndrome should also include the absence of Q-waves or significant ST segment elevation and presence of normal precordial R-wave progression.

References:

1. Gerson, M.C., et al., *Exercise-induced U-wave inversion as a marker of stenosis of the left anterior descending coronary artery*. Circulation, 1979. **60**(5): p. 1014-20.
2. Gerson, M.C. and P.L. McHenry, *Resting U wave inversion as a marker of stenosis of the left anterior descending coronary artery*. Am J Med, 1980. **69**(4): p. 545-50.
3. de Zwaan C, B.F., Wellens HJ. , *Characteristic electrocardiographic pattern indicating a critical stenosis high in left anterior descending coronary artery in patients admitted because of impending myocardial infarction*. Am Heart J., 1982. **103**((4pt2)): p. 730-6.
4. Wellens, H.J., *Bishop lecture. The electrocardiogram 80 years after Einthoven*. J Am Coll Cardiol, 1986. **7**(3): p. 484-91.
5. de Zwaan, C., et al., *Angiographic and clinical characteristics of patients with unstable angina showing an ECG pattern indicating critical narrowing of the proximal LAD coronary artery*. Am Heart J, 1989. **117**(3): p. 657-65.
6. Win Htut Oo SZ, Khalighi K, Kodali A, May C, Aung TT, Snyder R. *Omnious T-wave inversions: Wellens' syndrome revisited*. J Community Hosp Intern Med Perspect. 2016 Sep 7;6(4):32011.
7. Rhinehardt J, Brady WJ, Perron AD, Mattu A. *Electrocardiographic manifestations of Wellens' syndrome*. Am J Emerg Med. 2002 Nov;20(7):638-43
8. Goor, Y., et al., *Critical myocardial ischemia: minor electrocardiograph changes--Wellens' syndrome*. Isr Med Assoc J, 2003. **5**(2): p. 129-30.
9. Kahn, E.C. and K.B. Keller, *Wellens' syndrome in the emergency department*. J Emerg Nurs, 1991. **17**(2): p. 80-5.
10. Kardesoglu, E., et al., *Wellens' syndrome: a case report*. J Int Med Res, 2003. **31**(6): p. 585-90.
11. Rhinehardt, J., et al., *Electrocardiographic manifestations of Wellens' syndrome*. Am J Emerg Med, 2002. **20**(7): p. 638-43.
12. Tandy, T.K., D.P. Bottomy, and J.G. Lewis, *Wellens' syndrome*. Ann Emerg Med, 1999. **33**(3): p. 347-51.
13. Vanpee, D., et al., *Wellens' syndrome*. Ann Emerg Med, 1999. **34**(5): p. 684-5.
14. Conover, M., *Wellens' syndrome: identification of critical proximal left anterior descending stenosis*. Crit Care Nurse, 1990. **10**(2): p. 30-6.

15. Miwa, K., et al., *Exercise-induced negative U waves in precordial leads as a marker of viable myocardium in patients with recent anterior myocardial infarction*. Int J Cardiol, 2000. **73**(2): p. 149-56.
16. Tamura, A., et al., *Significance of negative U waves in the precordial leads during anterior wall acute myocardial infarction*. Am J Cardiol, 1997. **79**(7): p. 897-900.
17. Gregory, S.A., et al., *Inverted U waves*. Am J Med, 2006. **119**(9): p. 746-7.
18. Win Htut Oo SZ, Khalighi K, Kodali A, May C, Aung TT, Snyder R. Omniphasic T-wave inversions: Wellens' syndrome revisited. J Community Hosp Intern Med Perspect. 2016 Sep 7;6(4):32011.
19. Ozdemir S, Cimilli Ozturk T, Eyinc Y, Onur OE, Keskin M. Wellens' Syndrome - Report of two cases. Turk J Emerg Med. 2016 Mar 11;15(4):179-81
20. Derda AA, Widder JD, Bauersachs J, Napp LC. The Value of an Immediate Invasive Strategy in Acute Coronary Syndrome: In Memoriam of Henrick Joan Joost (Hein) Wellens (1935 to 2020). JACC Cardiovasc Interv. 2020 Oct 12;13(19):2303-2304.
21. Movahed MR. Wellens' syndrome or inverted U-waves? Clin Cardiol. 2008 Mar;31(3):133-4.
22. Said S, Bloo R, de Nooijer R, Slootweg A. Cardiac and non-cardiac causes of T-wave inversion in the precordial leads in adult

Figure legends:

Figure1: EKG Showing classic biphasic T waves in V2-V3 Consistent with Wellen Syndrome or inverted U wave sign

Figure 2: EKG a year earlier did not show biphasic T waves in V1-V2

Figure 3: Coronary angiogram revealed severe 3 vessel coronary artery disease with extensive involvement of proximal left anterior ascending artery