



Case Report

Cardiac Memory-induced T-wave Inversions After Temporary Ventricular Pacing

Geçici Ventriküler Pacing Sonrası Kardiyak Hafızaya Bağlı T Dalgası İnversiyonları

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ABSTRACT

Cardiac memory refers to T-wave inversions (TWI) on electrocardiograms (ECGs) after an episode of abnormal ventricular activation or wide electrical activity of ventricular muscles (QRS complex). We present the case of a 62-year-old woman with symptomatic bradycardia due to sinus pause. She immediately underwent temporary transvenous ventricular pacing. In the following days, intrinsic normal sinus rhythm was resumed at 69 bpm and a narrow QRS was observed (97 ms). Additionally, deep TWI was observed in leads II, III, aVF, and V3-V6. The distribution of TWI, normal echocardiogram and laboratory results, non-significant coronary angiogram, and recent right ventricular pacing correspond to possible cardiac T-wave memory. Follow-up 12-lead ECG four weeks later showed that T-wave morphology returned to normal baseline. This further confirmed the final diagnosis of cardiac memory-induced TWI. Recognizing cardiac memory-induced TWI is important for physicians to facilitate proper evaluation and management of TWI and prevent unnecessary further cardiac diagnostic tests.

Keywords: Cardiac memory, T-wave inversion, wide QRS, ventricular pacing, bradycardia

ÖZ

Kardiyak hafıza, anormal ventriküler aktivasyon veya geniş QRS epizodundan sonra elektrokardiogramlarda (EKG) görülen T dalgası inversiyonlarını (TWI) ifade etmektedir. Bu yazıda, sinüs duraklamasına bağlı semptomatik bradikardisi olan 62 yaşında bir kadın hasta sunuldu. Hastaya hemen geçici transvenöz ventriküler pacing uygulandı. Takip eden günlerde, intrinsik normal sinüs ritmi 69 bpm'de devam etti ve dar QRS gözlendi (97 ms). Ek olarak, II, III, aVF ve V3-V6'da derin TWI gözlendi. TWI dağılımı, normal ekokardiyogram ve laboratuvar sonuçları, anlamlı olmayan koroner anjiyogram ve yakın zamandaki sağ ventrikül pacing'i olası kardiyak T dalgası hafızasına karşılık gelmektedir. Dört hafta sonra takipte çekilen 12 derivasyonlu EKG, T dalgası morfolojisinin normal başlangıça döndüğünü gösterdi. Bu, kardiyak hafızaya bağlı TWI'nin nihai tanısını doğrulamıştır. Kardiyak hafızaya bağlı TWI'nin tanınması, doktorlar için TWI'nin doğru değerlendirilmesi ve yönetimini kolaylaştırmak ve gereksiz ileri kardiyak tanısal testleri önlemek açısından önemlidir.

Anahtar Kelimeler: Kardiyak hafıza, T dalgası inversiyonu, geniş QRS, ventriküler pacing, bradikardi

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INTRODUCTION

The typical definition of cardiac memory refers to the T-wave changes [usually T-wave inversions (TWI)] on the electrocardiogram (ECG) after an episode of abnormal ventricular activation or wide QRS complex that appears after the pattern of normal ventricular activation returns (1,2). TWI as cardiac memory manifestations often mimic other pathological conditions that may manifest as TWI, such as myocardial infarct or ischemia, myopericarditis, takotsubo cardiomyopathy, and cerebrovascular accident (1,2). Here we report a case of cardiac memory manifesting as new-onset TWI after ventricular pacing in a patient with symptomatic bradycardia due to sinus pause.

CASE REPORT

A 62-year-old female presented to the emergency room with intermittent chest pain and dizziness. She had a history of uncontrolled hypertension for one year. On arrival, blood pressure was 144/76 mmHg, heart rate was 20-30 beats per minute (bpm), respiratory rate was 22 breaths per minute, and oxygen saturation was 97% on free air. Other physical examinations were within normal limits. A 12-lead ECG showed periodic sinus pause at a rate of 30 bpm (Figure 1). Bedside echocardiography revealed normal left ventricle systolic function (ejection fraction of 68% by teicholz) and no abnormal wall motion. Serial troponin levels were negative. Electrolytes (sodium, potassium, chloride, calcium, and magnesium) and thyroid function tests were within the normal range. She was diagnosed with symptomatic bradycardia due to sinus pause, and temporary transvenous ventricular pacing was immediately performed. A 12-lead ECG was obtained after temporary pacing insertion, which showed a right ventricular paced rhythm (QRS width 150 ms) at 75 bpm (Figure 2). The patient was then scheduled for permanent pacemaker (PPM) implantation because of symptomatic bradycardia (sinus pause) with no potential causes.

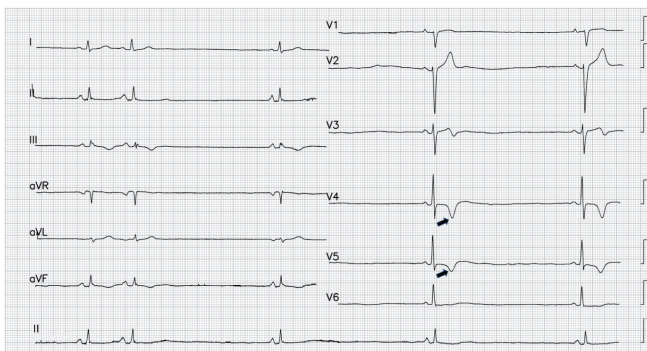


Figure 1. Electrocardiogram on arrival showed periodic sinus pause with a rate of 30 bpm, narrow QRS complex, and T-wave inversions in V4-V5 (arrows)

On the following days, intrinsic normal sinus rhythm was resumed at a rate of 69 bpm and narrow QRS (97 ms) was observed on ECG (Figure 3). Additionally, deep TWI was observed in leads II, III, aVF, and V3-V6 (Figure 3). She was asymptomatic at this time. However, suspicion of myocardial ischemia or infarction is raised. Repeat echocardiography revealed no wall motion abnormality. Troponin and electrolytes were within the normal range. Coronary angiography was then performed before PPM implantation. There was no significant stenosis found on angiography (Figure 4). Finally, due to the T-wave direction in sinus rhythm following (remembering) the QRS complex direction during the previous episode of wide QRS or abnormal ventricular activation (ventricular pacing), TWI was concluded to be a manifestation of cardiac memory after ventricular pacing. A dual chamber PPM DDDR was implanted successfully. She was then discharged with no symptoms. Follow-up ECG at the outpatient clinic four weeks later showed that T-wave morphology had returned to normal baseline (Figure 5).

Written informed consent for the publication of this case report and accompanying images was obtained from the patient.

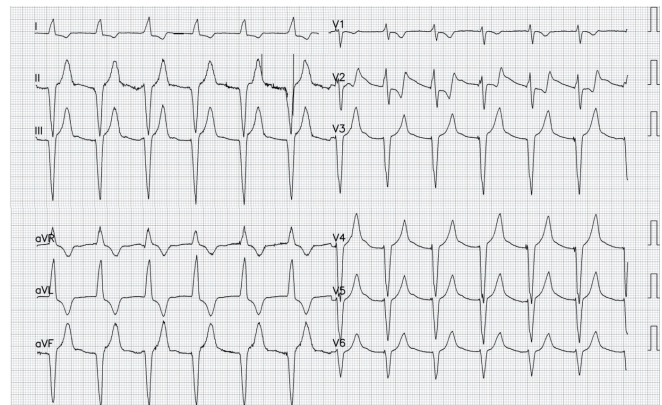


Figure 2. Electrocardiogram after temporary pacing insertion showed right ventricular paced rhythm (QRS width 150 ms) at 75 bpm

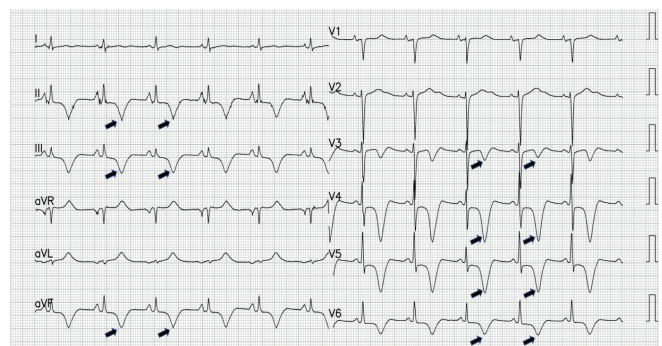


Figure 3. Electrocardiogram on the following days showed intrinsic sinus rhythm with a normal rate of 69 bpm, narrow QRS (97 ms), and deeper T-wave inversions were observed in leads II, III, aVF, and V3 through V6 (arrows)

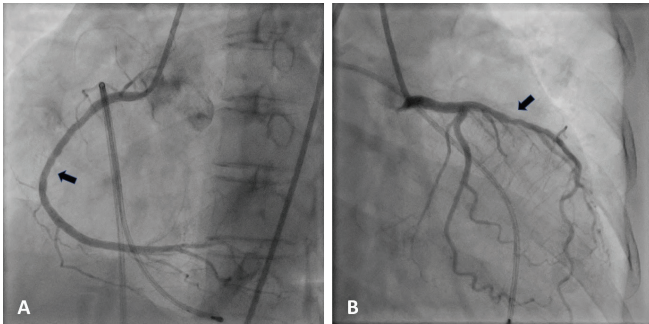


Figure 4. Coronary angiography revealed (A) irregularity at mid right coronary artery (arrow), and (B) non-significant stenosis at the proximal to mid left anterior descending artery (arrow). A temporary pacing lead was seen in the right ventricle

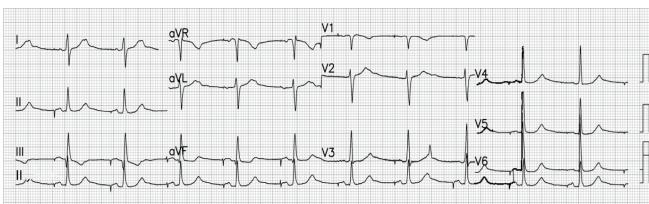


Figure 5. Follow-up electrocardiogram at the outpatient clinic four weeks later showed atrial paced-ventricular sensed rhythm with narrow QRS (99 ms) and normal T-wave morphology

DISCUSSION

Cardiac memory is a common but rarely recognized phenomenon in which T-waves in a sinus or intrinsic rhythm follow or remember the QRS vector from a previous abnormal activation (1,3). It manifests on ECG or vector cardiogram as TWI during any intrinsic or sinus rhythm with normal ventricular activation that occurs after periods of abnormal myocardial activation (e.g. after ventricular pacing, ventricular tachycardia, left bundle branch block, intermittent ventricular preexcitation, and pre-excitation ablation) (4,5). Cardiac memory is associated with prolonged repolarization in the initial active area (1). The cellular mechanisms of cardiac memory are currently unclear, but changes in several ion channels, cell coupling, and receptors, including the temporary outward current, I_{to} , I_{Ca} , Na/Ca exchanger, IKr , stretch-activated receptors, $AT1$ receptors, and redistribution of gap junctions, have been reported (1,3,6). During intrinsic sinus rhythm with a normal rate, a new and deeper TWI (Figure 3) in this patient appeared in the lead with a negative QRS complex during the previous ventricular paced rhythm (leads II, III, aVF, and V3 to V6). The distribution of TWI, normal echocardiogram and laboratory results, non-significant coronary angiogram, and recent right ventricular pacing correspond to possible cardiac t-wave memory. TWI on arrival might be caused by bradycardia (Figure 1).

Cardiac memory may persist for several weeks after ventricular conduction returns to normal (1). Attenuation of the TWI in this patient was documented four weeks later on a follow-up 12-lead ECG in which T-wave morphology returned to normal baseline. This further confirmed the final diagnosis of cardiac memory-induced TWI.

Once other causes of TWI are ruled out, cardiac memory-induced TWI does not require specific treatment (5). In patients without pacemakers, cardiac memory may imply intermittent ventricular preexcitation, intermittent left bundle branch block, or paroxysmal ventricular tachycardia, and ambulatory heart rhythm monitoring may be appropriate to determine the potential causes (4,5). Cardiac memory in this patient was most likely secondary to temporary ventricular pacing; hence, no further workup or treatment was necessary.

Recognizing cardiac memory as a potential cause of TWI is essential to prevent unnecessary hospitalization, further cardiac diagnostic workup, or cardiac catheterization. T-wave morphological analysis can help distinguish ischemia-induced from cardiac memory-induced TWI after right ventricular pacing. A study by Shvilkin et al. (7) demonstrated that the combination of 1) positive T-wave in aVL and isoelectric or positive T-wave in lead I and 2) maximum TWI in the precordial lead greater than that in the inferior lead, as shown in this patient, has a sensitivity of 92% and specificity of 100% for cardiac memory-induced TWI from right ventricular pacing.

Cardiac memory is a pattern of T-wave changes, usually TWI, following the resolution of abnormal ventricular activation or wide QRS rhythm. Recognizing the cardiac memory phenomenon is essential for physicians to facilitate appropriate evaluation and management, which may help avoid unnecessary hospitalization and further cardiac diagnostic tests.

ETHICS

Informed Consent: Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Authorship Contributions

Surgical and Medical Practices: E.P.B.M., D.A.R., R.J., B.B.D., M.R.A., Concept: E.P.B.M., D.A.R., B.B.D., Design: E.P.B.M., D.A.R., R.J., M.R.A., Data Collection or Processing: E.P.B.M., D.A.R., M.R.A., Analysis or Interpretation: E.P.B.M., D.A.R., R.J., B.B.D., Literature Search: E.P.B.M., D.A.R., M.R.A., Writing: E.P.B.M., D.A.R., R.J., B.B.D., M.R.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. Shvilkin A, Huang HD, Josephson ME. Cardiac memory: diagnostic tool in the making. *Circ Arrhythm Electrophysiol*. 2015;8:475-82.
2. Polito SC, Giordano JA, Cooper BL. Cardiac Memory-induced T-wave Inversions. *Clin Pract Cases Emerg Med*. 2020;4:181-4.
3. Siontis KC, Wen S, Asirvatham SJ. Cardiac memory for the clinical electrophysiologist. *J Cardiovasc Electrophysiol*. 2019;30:2140-3.
4. Chen-Scarabelli C, Scarabelli TM. T-wave inversion: cardiac memory or myocardial ischemia? *Am J Emerg Med*. 2009;27:898.e1-4.
5. Waks JW, Steinhaus DA, Shvilkin A, Kramer DB. Post-pacemaker T-wave Inversions: Cardiac Memory. *Am J Med*. 2016;129:170-2.
6. Jeyaraj D, Wan X, Ficker E, Stelzer JE, Deschenes I, Liu H, et al. Ionic bases for electrical remodeling of the canine cardiac ventricle. *Am J Physiol Heart Circ Physiol*. 2013;305:H410-9.
7. Shvilkin A, Ho KK, Rosen MR, Josephson ME. T-vector direction differentiates postpacing from ischemic T-wave inversion in precordial leads. *Circulation*. 2005;111:969-74.