

## T Wave Alternans Preceding ST Segment Depression as a Sign of Myocardial Ischemia During Treadmill Test.

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Submitted : 9 July 2022 ; Published : 16 August 2022

**Citation:** Dr S. R. Mittal, Govind Mittal. T wave alternans preceding ST segment depression as a sign of myocardial ischemia during treadmill test. I J cardio & card iso, 2022; 3(1): 1-4.

### Abstract

We observed a case where T wave alternans preceded classical ischemic ST segment depression during treadmill stress test. T wave alternans is considered to suggest increased susceptibility to ventricular arrhythmias. Our case suggests that T wave alternans can also be a marker of myocardial ischemia and can precede classical ischemic ST segment depression during treadmill stress test.

**Keywords:** Electrocardiography,Electrical alternans, Ischemic heart disease, Treadmill test and T wave

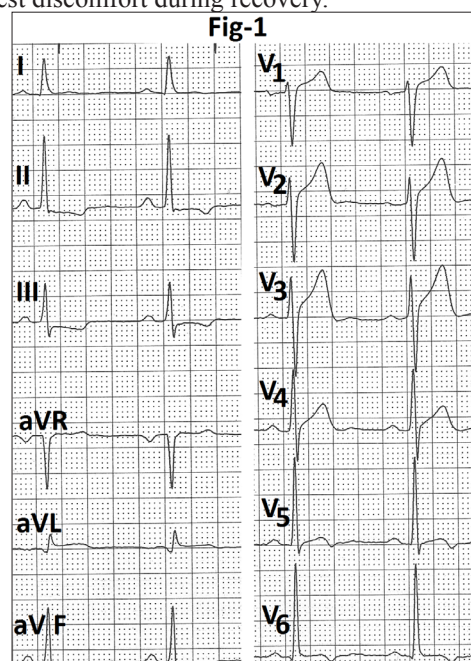
### Introduction

Electrical alternans is an electrocardiographic finding defined as a change in the electrical activity of the heart in alternate beat in the presence of a regular rhythm (Chung DK & Chung EK, 1971). When the rhythm is irregular, it is not called electrical alternans (Mittal SR., 2005). T wave alternans is considered a marker of increased risk of ventricular tachyarrhythmias (Mirvis et al., 2019; de Luna et al., 2017; Narayan, 2006). T wave alternans has been shown to occur in patients with chronic heart disease (Mirvis et al., 2019) or in patients with long QT syndromes (de Luna et al., 2017). We observed a case where T wave alternans preceded ST segment depression classical of myocardial ischemia during treadmill test. To the best of our knowledge, such a correlation has not been reported (Schamroth, 1982; Thomas & Ellestad, 2017; Thomas et al., 2018; Balady et al., 2019).

### Case report

A 38 years male presented for treadmill test. He had history suggestive of angina on effort. Cardiovascular system examination was normal. Resting heart rate was 66/minute and resting blood pressure was 120/90 mm of Hg. Resting electrocardiogram (Fig.1) showed small q wave with mild ST segment elevation in lead aVL, mild (0.05mv) ST segment depression in leads II, III, aVF, inversion of terminal part of T wave in lead V<sub>5</sub> and symmetrical shallow T wave inversion in lead V<sub>6</sub>. He could exercise for 10:02 minutes (11.3 Mets). Peak heart rate was 164/minute and peak blood pressure was 180/90

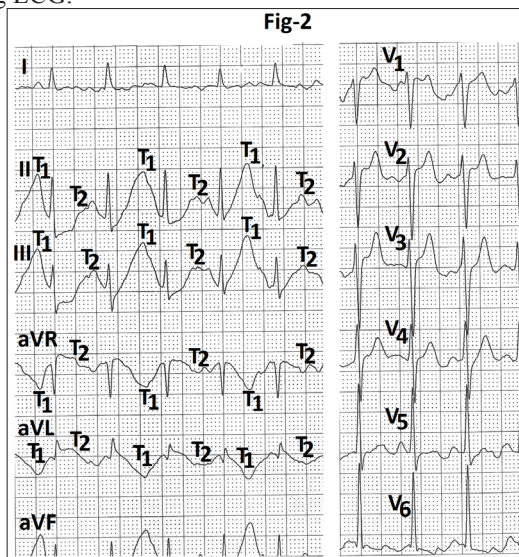
mm Hg. He complained of breathlessness at peak exercise and mild chest discomfort during recovery.



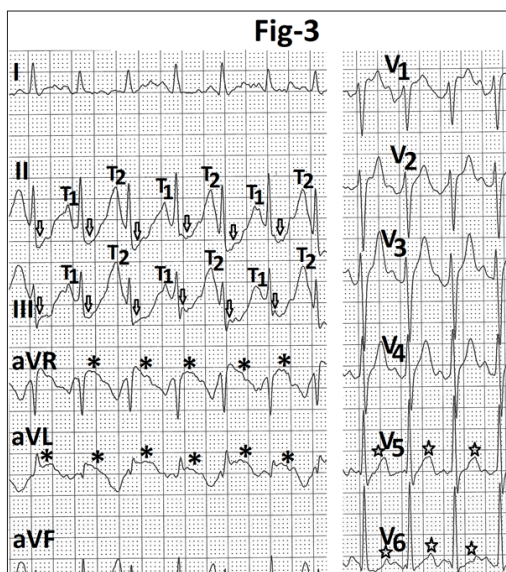
**Figure 1:** Resting electrocardiogram showing q wave with mild ST segment elevation in lead aVL, mild ST segment depression in leads II, III, aVF, inversion of terminal part of T wave in lead V<sub>5</sub> and symmetrical shallow T wave inversion in lead V<sub>6</sub>.

Review of raw electrocardiograms recorded at the end of second stage (exercise time six minutes- Fig.2) revealed T wave alternans (marked T<sub>1</sub> and T<sub>2</sub>) in leads II, III, aVR and aVL. Electrocardiogram recorded at the end of third stage (exercise time nine minute - Fig.3) also showed T wave alternans in limb leads II, III and ST segment elevation in leads aVR and aVL (marked). There was normalisation of inverted T wave of lead V<sub>5</sub> and V<sub>6</sub> (marked). At peak exercise (exercise time 10:01 - Fig.4). There was significant (4mm) horizontal or down sloping ST segment depression (marked) in leads II, III and significant (around 2.5mm) ST segment elevation (marked) in leads aVR and aVL. There was no significant change in precordial leads. Electrocardiogram recorded at end of first minute of recovery (Fig.5) and third minute of recovery (Fig.6) did not show any ST segment change or T wave alternans. Electrocardiogram recorded at the end of fifth minute of recovery (Fig.7) was like resting ECG.

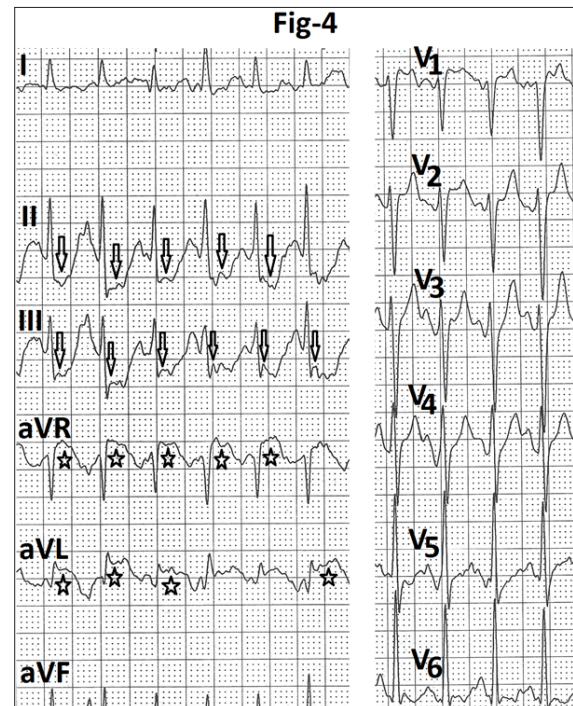
depression in leads II, III (T<sub>1</sub> and T<sub>2</sub>) and ST segment elevation in lead aVR and aVL (marked) and normalization of inverted T wave in V<sub>5</sub> and V<sub>6</sub> (marked)



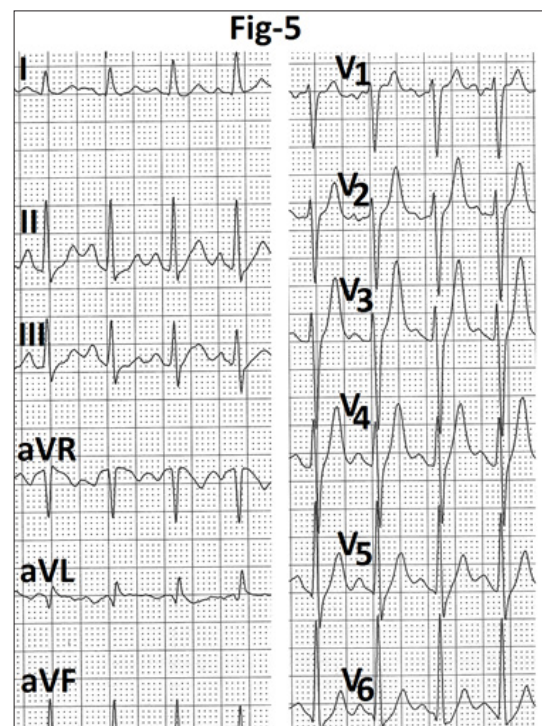
**Figure 2:** Electrocardiogram recorded at the end of second stage of exercise showing T wave alternans (T<sub>1</sub> and T<sub>2</sub>) in leads II, III, aVR and aVL.



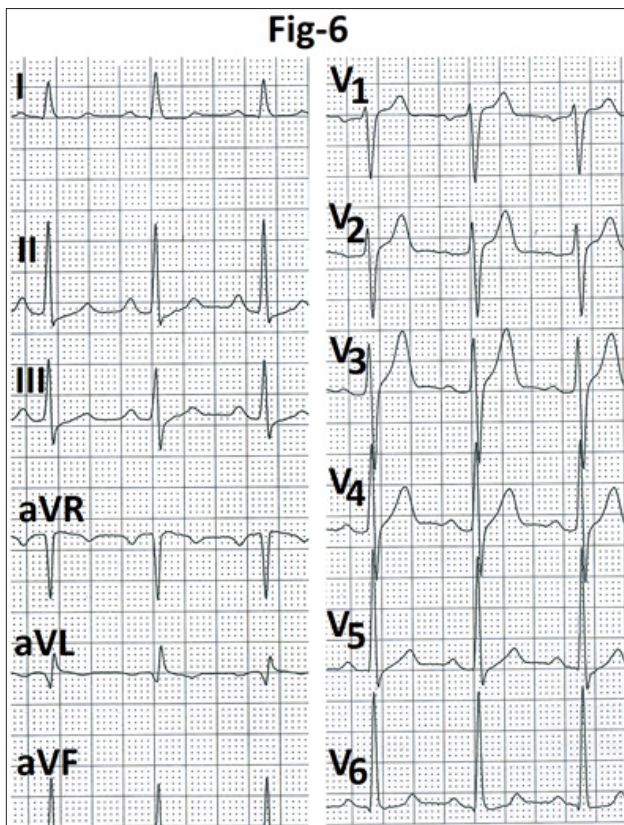
**Figure 3:** Electrocardiogram recorded at the end of third stage of exercise showing T wave alternans with ST segment



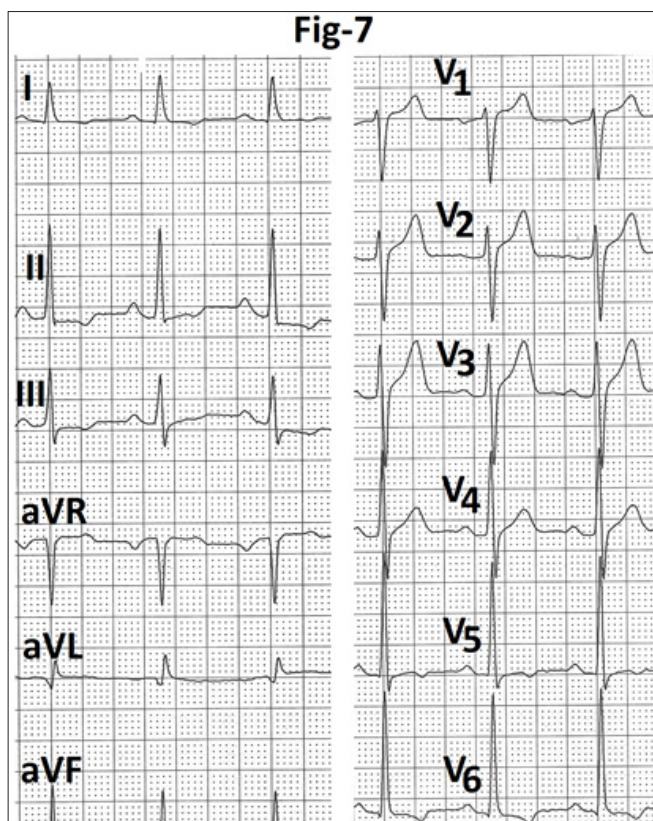
**Figure 4:** Electrocardiogram recorded at peak exercise showing increased ST segment depression (marked) in lead II, III and increased ST segment elevation in leads aVR and aVL (marked).



**Figure 5:** Electrocardiogram recorded at the end of first minute of recovery not showing any ST segment depression or T wave alternans.



**Figure 6:** Electrocardiogram recorded at the end of third minute of recovery. There is no ST segment depression or T wave alternans



**Figure 7:** Electrocardiogram recorded at the end of fifth minute of recovery. It is similar to resting electrocardiogram

## Discussion

Resting electrocardiogram of our patient showed q wave with ST segment elevation in lead aVL, terminal T wave inversion in lead V<sub>5</sub> and symmetrical T wave inversion in lead V<sub>6</sub>. These findings are suggestive of old apical/lateral infarction (Mirvis et al., 2019; de Luna et al., 2017; Wagner & Lim, 2001). Mild ST Segment depression in leads II, III, aVF could be reciprocal changes or could be due to additional inferior sub endocardial ischemia. There was significant (4mm) ST segment depression at peak exercise suggestive of significant coronary artery disease (Goldschlager et al., 1976). Normalisation of inverted T wave of leads V<sub>5</sub> and V<sub>6</sub> is also suggestive of myocardial ischemia (Thomas et al., 2018).

Our patient also had ST segment elevation in leads aVR and aVL. ST segment elevation in a lead with Q wave (lead aVL in our case) is associated with akinesia/dyskinesia secondary to an old myocardial infarction related to an occluded or high grade coronary lesion (Thomas et al., 2018; Arora et al., 1988). ST segment elevation in lead aVR suggests left main or ostial LAD disease (Thomas et al., 2018; Uthamalingam et al., 2011; Ellestad, 2008). In our case findings in the resting electrocardiogram and during stress suggest significant coronary artery disease. Our case showed T wave alternans in limb leads before classical ST segment depression in these leads. T wave alternans has been reported as a marker of increased risk of ventricular tachycardia in patients with chronic heart disease (Mirvis et al., 2019; Narayan, 2006). Our case shows that T wave alternans can also appear as an early electrocardiographic manifestation of ischemia during treadmill test.

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