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High incidence of ST-T changes in women during tilt-table testing ☆

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Abstract

Introduction: We have observed electrocardiographic (ECG) changes primarily in women during tilt table testing.

Methods: We reviewed 12 lead ECGs during tilt studies between 2012 and 2016 for changes in ST segments and T waves during tilt table testing. Patients with distinctly abnormal baseline ECGs were excluded.

Results: Of the 180 tilt studies, 117 (65%) were in women. There were 32 patients with ECG changes during tilting. Of these, 28 (87.5%) were in women with an average age of 45 years. None had a history of CAD or exertional chest pain. Echocardiograms were available in 21 of the 28 women with tilt induced ECG changes and all were normal. ECG changes during tilt table testing were found in 4/64 (6.25%) of men. The occurrence of ST-T wave changes during tilt testing was significantly higher among women compared to men, with a p value of 0.008.

Of the 28 women with ECG changes during tilt, 11 had T wave inversions alone. ST segment depression alone was noted in 7 women. There were 10 women who had both ST segment depression and T wave inversions. Changes occurred immediately upon tilting in 6. In the remaining, they occurred at an average of 4.8 ± 4 min after tilting. The slight increase in heart rate in patients with ECG changes was similar to that in the patients without new ECG changes. The ECG changes were not related to the presence of syncope.

Conclusions: ECG changes during the testing was observed at a relatively high incidence primarily in women. The clinical significance of these repolarization changes during tilt testing is unknown. These ECG changes during tilt testing may correlate with the high incidence of false positive ECGs in women during exercise testing but do not necessarily indicate the presence of ischemic coronary disease. Additional research is needed to explain this phenomenon.

Keywords: Tilt table testing; 12-Lead ECG; Repolarization changes; Young women; Postural variations; Autonomic imbalance

Introduction

Passive head upright tilt table (HUTT) testing is frequently performed to assist in the diagnosis and cause of syncope. Kenny et al [1] first reported tilt table testing in 1986 in fifteen patients with unexplained syncope. Since then, several protocols with varying sensitivity and specificity have been proposed and provocative agents are used to improve the diagnostic utility of this test [2]. The European Society of Cardiology recommends tilt table testing for patients with unexplained syncope in a high risk situation or recurrent syncope in the absence of organic heart disease [3]. It is also recommended in patients with syncope who have organic heart disease, after cardiac causes of syncope have been thoroughly excluded.

The test is performed on a tilt table which can move the patient from a supine to an upright position. The patient is secured to the table with restraints and a foot board. The study is done following a 4 h fast. A standard tilt protocol [3] consists of a resting supine phase that lasts for 5–20 min, followed by a passive tilt phase. The initial tilt phase may last for 20–45 min at an inclination of 60–70°. Provocative agents such as intravenous isoproterenol at incremental doses (usually <3 mcg/min) to increase the average heart rate by approximately 20–25% [4] or sublingual nitroglycerin at a dose of 300–450 mcg [5] are then used to unmask abnormal postural reflexes. The patient is then returned to the supine position. Throughout the test, noninvasive blood pressure and an ECG are recorded.

The occurrence of syncope or presyncope and simultaneous hemodynamic changes such as reflex hypotension/bradycardia or symptomatic orthostatic hypotension are

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Table 1
Baseline characteristics of patients with ECG changes during tilt table testing.

Age (overall), in years (N = 33)	49 ± 23
Age (females), in years (N = 28)	46 ± 23
Age (males), in years (N = 4)	62 ± 7
CAD	0
Hypertension	11 (34%)
Diabetes	1 (3%)
Hyperlipidemia	7 (22%)
Indications for tilt test	
Syncope	16 (50%)
Dizzy spells	11 (34%)
Near syncope	5 (16%)

necessary to consider the test as positive [3]. The diagnosis of postural orthostatic tachycardia syndrome and psychogenic pseudosyncope can also be made using the tilt table study [3].

At our institution, 12 lead ECG's are recorded every minute during the tilt table studies. We have observed ECG changes during the tilt studies, predominantly in young women. These changes may not be recognized if single lead ECG's are used during tilt studies. This study evaluated the frequency of the ECG changes during tilt testing.

Materials and methods

After obtaining IRB approval, we performed a retrospective chart review of all tilt studies that were done at our institution between 2012 and 2016. We reviewed the medical charts for age, gender, echocardiograms, stress test findings when available, and tilt test results for each patient. We examined the 12 lead ECGs during tilt studies for ST segment depression and T wave inversion during rest, tilting and recovery. Patients with bundle branch block, or those who had an abnormal ECG as defined by the presence of T wave inversions or ST segment abnormalities prior to tilting were excluded. We considered T wave flattening as nonspecific and not an abnormality. ECG abnormalities were then classified as T wave changes, ST segment changes or both. The leads in which these changes were seen were noted.

Our tilt protocol [5] consists of recording heart rate, blood pressure and a 12 lead ECG while the patient is supine, followed by 20 min of passive head upright tilt at 60°. The test is continued for 15 min after the administration of 400 mcg of nitroglycerin by sublingual spray. 12 lead ECGs are recorded every minute during the study. The most common indication for the tilt test was syncope of unknown etiology (in 50% of these patients); other indications being dizzy spells (34%) and near syncope (16%) (Table 1). All the studies were supervised by the senior author of this paper (Dr. Marcus).

The study was deemed positive if symptoms of syncope or presyncope were associated with hemodynamic abnormalities such as hypotension and or bradycardia. A positive test was then subclassified into either type I (mixed), type 2 (cardioinhibitory) or type 3 (vasodepressor) [6].

Results

Of the 180 tilt studies performed between 2012 and 2016, 117 (65%) were in women. There were 32 individuals (18%) who had ECG changes during tilting. Twenty-eight (87.5%) of these were in women with an average age of 45 years. The remaining 4 (12.5%) were in men. None of the 32 patients had a history of CAD or exertional chest pain. Therefore, ECG changes during tilt testing for syncope was observed in 24% of women and in 6% of men. Tilt test positivity among those with ECG changes during the tilt was 50%.

Baseline supine ECGs were normal in 29 of the 32 patients, of whom 25 were women. There were 3 women with flat T waves at baseline. Echocardiograms were available in 25 patients with ECG changes of whom 21 were women. They were all normal.

Of the 28 women with new ECG changes during tilt, 11 had isolated T inversions and 7 had only ST segment depression. Two of the 11 had T wave inversions in precordial leads, one in limb leads and the remaining 8 in both precordial and limb leads. One had ST segment depression in limb leads, one in precordial leads and the remaining 5 in both precordial and limb leads. There were 10 women who had both ST segment depression and T wave inversions. An example is shown in Fig. 1. ECG changes occurred immediately upon tilting in six individuals. In the remaining, they occurred at an average of 4.8 ± 4 min after tilting. The average baseline heart rate was 88 ± 18 beats per minute. Although the heart rate increased by an average of 15 beats per minute in 18 individuals, the mean change in heart rate was similar in individuals with and without tilt related ECG changes.

A total of 10 patients had persistent ECG changes during recovery. The ECG changes reverted to baseline during recovery after an average of 5.2 ± 4.9 min. When the ECG changes reverted to baseline, a decrease in heart rate occurred at an average of 9 beats per minute.

Discussion

This study showed that ST/T changes on the ECG occurred in 18% of patients during tilt table testing of whom 87.5% were women. None had a history of ischemic heart disease. The changes were unrelated to the results of the tilt study. ECG changes resolved in the majority (64%) of the patients immediately upon assuming the supine position.

An analysis of ECG changes during tilt in 150 patients was reported by Mayuga et al. from the Cleveland Clinic [7]. It is difficult to compare their results of ECG changes with ours because their protocol was different. They recorded ECGs during supine resting, at 30° tilt for 2 min, at 45° tilt for 2 min and at 30° tilt for 45 min followed by 5 min in the supine position. In V5, the T wave became negative in 32 patients. Another difference from our study was that the postural orthostatic tachycardia syndrome is found in 67 of their patients but was present in only 2 patients in our study. We found ECG changes in 18% of our patients including 24% in women undergoing the tilt study. Fifty percent of patients with ECG changes had tilt test positively.