CONFOUNDING T-WAVE INVERSION

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In the medical community, the nonspecific finding of T-wave inversion warrants further investigation. An electrocardiogram may be an essential component of a surgical risk evaluation. Patients who show a T-wave inversion on a preoperative electrocardiogram require further investigation to distinguish between pathological and benign T-wave inversion. Optimizing patients' safety during the perioperative experience is the ultimate clinical outcome. (American Journal of Critical Care. 2007;16:137-140)

T-wave inversion can derail a preoperative medical evaluation, prompting expensive testing and causing an unexpected delay in proceeding to surgery. Millions of people in the United States have noncardiac surgery each year.1 A medical consultation before surgery may be requested to promote optimal postoperative outcomes or to prevent unexpected delay or cancellation of an elective surgical procedure.2 Our outpatient preoperative clinic provides cardiac risk stratification guided by the algorithm published by the American College of Cardiology and the American Heart Association in 1996 and revised by Eagle et al3 in 2002. The clinic also provides medical optimization of preexisting disease, education of patients, and perioperative recommendations. Patients are evaluated on an individual basis by obtaining a thorough history, doing a physical examination, and reviewing pertinent diagnostic studies. An essential part of the evaluation is the assessment of risk for an untoward perioperative cardiac event.

An estimated 13 million people in the United States have known coronary heart disease.4 An even larger number of Americans have known risk factors for coronary artery disease (CAD). A preoperative electrocardiogram (ECG) is obtained on men 45 years or older, women 55 years or older, and patients with known or suspected CAD. An ECG is considered for all adult patients undergoing major surgery.

The T wave of an ECG tracing represents ventricular repolarization. In adults, the T wave is normally an upright waveform or positive deflection from the baseline in leads I, II, aVL, aVF, and V4 through V6, and it can be variable in leads III and V1 through V3.5 A negative deflection of the T wave (T-wave inversion) may indicate myocardial ischemia. Electrolyte imbalance, drug effects, disease of the central nervous system, and pneumothorax also can cause T-wave inversion.6

Case Presentation
A 40-year-old African American woman came to our preoperative clinic for evaluation before having an anterior communicating artery (ACA) aneurysm clipped. Her medical history included 20 years of migraine headaches that had responded to treatment only intermittently. Her cardiac risk factors included hyperlipidemia, hypothyroidism, hypertension, surgically induced menopause with hormone replacement therapy, current smoking, and a family history of CAD. Her medications included atenolol, conjugated estrogen, hydrochlorothiazide, levothyruxine, and zolmitriptan. A review of systems revealed daily headaches with variable degrees of intensity and photosensitivity. When questioned about her functional status, she reported that she could ascend 2 flights of stairs in less than 2 minutes at least 5 times a week without any cardiopulmonary distress.
An ECG revealed sinus bradycardia with a ventricular rate of 53/min and a flattened T wave in leads III and aVF (Figure 1). T-wave inversion was apparent in leads V1, V2, V3, and V4 with an RS morphology in V2, V3, and V4. Blood pressure was 126/66 mm Hg.

Upon further investigation, the patient reported that she had had an ECG 9 years before the current evaluation. The previous ECG (Figure 2) was located for comparison. T-wave inversion was present on the previous ECG. No significant difference between the 2 tracings was apparent.

Ordinarily, patients with T-wave inversion and multiple risk factors have further cardiac testing. In this instance, obtaining a thorough history led to the discovery of a prior ECG that, when compared with the current ECG, confirmed no acute signs of cardiac disease. Further cardiac stress testing that might put the patient at risk of rupturing her ACA aneurysm was avoided. This case illustrates the importance of using patients’ medical history and records for comparison when assessing and evaluating patients.

Questions

1. An ECG should be a part of the preoperative evaluation of every patient.
   a. True
   b. False

2. T-wave inversion on an ECG may indicate which of the following?
   a. Normal variant
   b. Electrolyte imbalance
   c. Subarachnoid hemorrhage
   d. Myocardial ischemia
   e. All of the above

3. A single ECG has no predictive value.
   a. True
   b. False

Answers

1. b. False

In 2003, Smetana and Macpherson7 recommended that men 40 years or older, women 50 years or older, and patients with risk factors for CAD who are having intermediate or higher risk surgery have an ECG as part of a comprehensive preoperative evaluation. This

Figure 1 Preoperative electrocardiogram obtained in 40-year-old African American woman before surgery to repair an anterior communicating artery aneurysm.

T-wave inversion can be caused by a number of factors including electrolyte imbalance, drug effects, disease of the central nervous system, and pneumothorax.
recommendation was based on a review of 16 prospective and retrospective trials evaluating the benefit of including an ECG as part of the preoperative evaluation.

2. e. All of the above

Anything that affects the physical position of the heart, its conduction system, or the repolarization properties of the myocardium can cause T-wave inversion. Normal variants include a persistent juvenile T-wave pattern with T-wave inversion in V1 through V3 with an rS or RS morphology. ECG variants, including T-wave findings, are more prevalent in women than in men and in African Americans than in whites. Global T-wave inversion is an idiopathic condition that occurs primarily in females, with prognosis dependent on comorbid disease.

Electrolyte imbalance, medication effect, and pulmonary disease are part of the differential diagnoses of T-wave inversion. Cerebral vascular accidents—primarily subarachnoid hemorrhage—can cause T-wave inversion, usually in the precordial and lateral leads. Central nervous system injury can provoke an increased catecholamine state, which in turn increases myocardial oxygen demand, thereby creating an oxygen demand-to-supply mismatch. In myocardial infarction, T-wave inversion may occur after the early signs of ST-segment elevation or hyperacute T waves have dissipated.

3. a. True

A single ECG has no predictive value; however, in 1991 Fesmire et al reported that change in the ECG pattern was predictive of myocardial disease.

A thorough history can reduce unnecessary testing when preoperative abnormalities are found on a patient’s electrocardiogram.

Summary

T-wave inversion on a preoperative ECG is often confounding and can delay surgery. Fortunately for this patient, who had no signs or symptoms of cardiac disease despite multiple risk factors for CAD, a previous ECG was available for comparison and revealed no change in the tracing during a 9-year period. Therefore, the decision was made not to pursue noninvasive cardiac stress testing, thereby avoiding stress on the ACA aneurysm, which could lead to a leak or rupture. The thorough medical history allowed this decision to be made with confidence. This case study illustrates the value of obtaining a thorough medical history on each patient. Once again,
it is imperative that nurses use patients’ histories and records when assessing and evaluating patients.

The patient proceeded to surgery while continuing to take her β-blocker, because this class of medication in the perioperative setting reduces mortality and the overall incidence of untoward cardiovascular events.13,14 The patient underwent a successful ACA aneurysm clipping and experienced a decline in headaches following surgery. The primary care provider addressed modification of risk factors for CAD.

FINANCIAL DISCLOSURES
None reported.

REFERENCES
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