Myocardial Ischemia

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Ranger Lock and Load!
From The Joint Council on In-Training Examinations
American Board of Anesthesiology-American Society of Anesthesiologists

"The following responses on the ITE suggested misconceptions in specific areas of the knowledge domain of Anesthesiology . . . based upon the performance of CA-3 residents taking the examination for ABA credit."

(I regard these "misconceptions" to be important because in a competitive situation questions related to them would serve the purpose of stratifying and discriminating within a group, thus meeting their goal. Go over these several times. Be careful! Expect these concepts to be disguised with distracters and land mines all around the target area. Ranger attack!)

According to the Board:
In the PACU shortly after cholecystectomy, an elderly shivering man has ischemic ST segment changes in the presence of a HR of 120 bpm and a BP of 220/120 mmHg (SpO₂ 97%). Almost 40% of CA-3 residents chose to first increase the FIO₂ or apply a warming blanket rather than to pharmacologically treat the tachycardia and hypertension in the presence of myocardial ischemia.

In both old and remembered questions, this issue has arisen. The underlying problem may indeed be shivering (or something else), but the fact is that this often takes time to treat and ongoing myocardial ischemia is being fueled by an unfavorable myocardial oxygen demand versus supply relationship. Besides preload and afterload, heart rate is a critical determinant. The first step in such a setting is to control hypertension and tachycardia and then direct attention and treatment to underlying causes such as shivering.

I. Coronary artery disease: Diagnosis and Treatment

1. In an awake patient, angina is the best sign of myocardial ischemia. In an anesthetized patient, ST segment depression of the V5 lead of the EKG is the best sign. (1 mm horizontal or down sloping from the baseline is significant.)

   a. Recall that ST segment changes (usually ST segment depression) are not seen until several physiologic events have occurred:
      1) Increased LVEDV-LVEDP
      2) Regional wall motion abnormalities
      3) Decreased ejection fraction
      4) ST segment changes

1Yao, FF. Ischemic Heart Disease and coronary Artery Bypass Grafting. Anesthesiology: Problem-Oriented Patient Management, Yao, FF, and Artusio, JF Jr. (eds), Lippincott.
2Reich, D, Joffe, D. Coronary Artery Diseases. Clinical Cases in Anesthesia, Reed, AP (ed), Churchill Livingstone.
2. More on Diagnosis: Primary monitors to diagnose intraoperative myocardial ischemia are the EKG and TEE. The PA catheter is a relatively insensitive monitor of myocardial ischemia. ('03 Ranger Remembered)

a. EKG: V5/lead II: 95% of ischemic events can be detected with these leads.
   1) EKG signs of myocardial ischemia:
      a) ST segment changes, either elevation or depression
         i. Depressed J point with upsloping ST segment
         ii. ST segment elevation
      b) T wave abnormalities
         i. T-wave inversion
      c) New arrhythmias
      d) New conduction abnormalities

2b. If one of these signs appears on the EKG, one should do the following:
   a. Institute immediate treatment of associated factors and consider other etiologies.
   b. Associated factors include hypo and hypertension, hypoxia, tachycardia, and anemia.
   In the setting of CAD, treat these as other etiologies are considered.
      1) Tachycardia: Esmolol—titrate up to about 0.5 mg/kg
      2) HTN/Tachy: Labetolol—titrate in 5-10 mg increments
      3) HTN: Labetolol or Hydralazine
      4) Hypotension: Neosynephrine—titrate in 50-100 mcg increments

3. Treatment: The primary treatment goal is to increase myocardial oxygen supply and decrease demand. Before any pharmacologic treatment is considered, hypovolemia and anemia must be ruled-out. Two goals in treatment of intraoperative myocardial ischemia include:
   a. Increase myocardial oxygen supply
      1) Increase O2 content:
         a) Increase FiO2 to 100%
         b) Treat anemia
      2) Increase coronary perfusion pressure
         a) CPP= DBP - LVEDP
      3) Increase subendocardial blood flow with TNG
   b. Decrease myocardial oxygen demand (HR, preload, and afterload)
      1) Treat preload increases with nitroglycerin
      2) Treat tachycardia with esmolol or propranolol
      3) Treat afterload increases and excessive inotropy with verapamil, the only vasodilator which decreases blood pressure without increasing heart rate.

4. Intraoperative signs of acute myocardial infarction:
   a. Hypotension, ST & T wave changes, new arrhythmias & conduction abnormalities.
   b. A depressed J point with upsloping of the ST segment suggests ischemia.
   c. When T waves become inverted, ischemia is subendocardial.
   d. ST segment elevation ≥ 1 mm is a sign of transmural myocardial ischemia.
   e. Only the appearance of Q waves ≥ 0.03 seconds in width is diagnostic of definite myocardial ischemia. These usually appear postoperatively.

II. Patients with a previous MI:
1. Elective surgery should be delayed for at least 6 months following a myocardial infarction. Even after 6 months, the 5% incidence of myocardial reinfarction is 50 times higher than the 0.15 incidence in patients undergoing the same procedure without a prior MI.

2. Myocardial reinfarction is most frequent on the third postoperative day.

3. Perioperative factors which increase the incidence of reinfarction:
   a. Preoperative hypertension
   b. Intraoperative hypotension
   c. Intrathoracic or intraabdominal procedures lasting longer than 3 hours
   d. Age ≥ 70.
III. Tests for further workup and evaluation of ischemic heart disease:
   a. Noninvasive tests: stress EKG, stress thallium, ECHO, radionucleotide studies
      1) Stress EKG (treadmill):
         a) It has only a 60% sensitivity in the detection of CAD. If suspicions are high and this test is nondiagnostic other tests would be in order.
         b) What constitutes a positive stress EKG:
            i. A positive test is ST depression ≥ 2 mm without a change in blood pressure or heart rate or the development of hypotension. (In a normal patient, blood pressure will increase.)
            ii. If ST depression occurs within the first three minutes of the test this is indicative of high grade disease. (Triple vessel disease, LM disease ≥ 50%, 70% stenosis of a major vessel other than the LM and CAD with LV dysfunction).
      c) The stress treadmill provides information in three critical areas:
         i. The "awake" blood pressure or heart rate at which a patient experiences symptoms or EKG changes.
         ii. Which leads to monitor.
         iii. Whether ischemia and arrhythmias are associated.
      2) Stress Thallium (Remembered. Pay attention.)
        a) Viable cells have normal Na⁺-K⁺ ion exchange pumps. Thallium binds to K⁺ and is pumped into normal cells. Areas of infarcted or ischemic tissue will remain "cold".
        b) Stress Thallium: exercise or dipyridamole induces normal coronaries to vasodilate. This produces coronary steal from marginal (already maximally vasodilated) coronary arteries. Marginal perfusion to these areas is indication for coronary angiography.
            i. Pre and post stress thallium may indicate areas that will benefit from myocardial revascularization. Redistribution indicates the existence of coronary steal and the presence of ischemic coronary artery disease. (Remembered)
      3) ECHO and radionucleotide scans are commonly used to evaluate ejection fraction and wall motion abnormalities.
   b. Invasive cardiac tests:
      1) Cardiac catheterization provides information regarding anatomy and functional severity of coronary artery disease. What is significant?
         a. Significant coronary stenosis is 70% stenosis of a major artery or 50% stenosis of the LM coronary artery.
         b. Right and left sided pressures as well as SVR and CO serve as a baseline for intraoperative changes as detected by the PA catheter.
         c. What constitutes poor LV function?
            i. Hypokinesis
            ii. Ejection fraction ≤ 40% (normal is 65%)
            iii. LVEDP ≥ 15
            iv. Cardiac index ≤ 2.2 (should be ≥ 3.0)

   Warrior Walk

   Try to avoid regrets, "opening a quarrel between the past and the present." Consider this:

   "There are many who would hold an inquest in the House of Commons on the conduct of Governments--and of the Parliaments, for they are in it, too--during the years which led up to this catastrophe. They seek to indict those who were responsible for our affairs. This also would be a foolish and pernicious process. There are too many in it. Let each man search his own conscience and search his speeches. I frequently search mine. Of this I am certain, that if we open a quarrel between the past and the present, we shall find that we have lost the future."
   (Winston Churchill-June 18, 1940)
Recent keywords of importance—most all of which are covered in *Big Blue* and/or at the Course:

1. Thallium scan: myocardial ischemia

Other related keywords from recent years:
(See cardiac chapter. Many key words relate to myocardial oxygenation.)

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**This is War! Let's Win.**

“...The greatest happiness is to vanquish your enemies, to chase them before you, to rob them of their wealth, to see those dear to them bathed in tears...”

Khan, Genghis (1162-1227)