Anesthesia for the Patients with Coronary Artery Disease

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Patients with coronary artery disease (CAD) undergoing surgery, particularly those with previous myocardial infarction, are at increased risk. Several authors have documented a high incidence of myocardial ischemia during the preoperative period (42%), the day of surgery (24%-37%), and within the first 2–3 days of surgery (40%) [1–5]. Most of this ischemia is silent and unrelated to adverse hemodynamic changes such as tachycardia, hypertension, or hypotension leading to increased myocardial oxygen demand or decreased supply. Since a significant relationship between the incidence of new ischemic episodes and the occurrence of postoperative myocardial infarction has been demonstrated [1, 2], the primary anesthetic goal in managing patients with CAD is the prevention of ischemia. In any ischemic event, time elapses between the detection of the problem, the identification of the cause, and its correction. Delay in any of these phases increases the likelihood of injury. Therefore, efforts in the anesthetic management of patients with CAD should mainly be directed toward improved methods for either prevention or earlier diagnosis of perioperative myocardial ischemia.

Clinical Possibilities and Limitations to Detect Perioperative Myocardial Ischemia

Angina Pectoris

A number of publications demonstrate that approximately 70% of the ischemic episodes in patients with CAD are not associated with angina, and that about 10%-15% of acute myocardial infarctions are silent [6]. Moreover, pre- or postoperative angina pectoris may be obscured by premedicants and residual anesthetic or analgesic drug effects.

Electrocardiography

A multiple-lead ECG system consists of four electrodes on the extremities and a fifth electrode in the V5 position, which allows for selection of any of seven different ECG leads (I, II, III, aVR, AVL, aVF, or V5). Leads II and V5 are usually displayed simultaneously, allowing for observation of both inferior wall and anterolateral ischemia. This system has become the standard way of monitoring patients with CAD. Sensitivity may be increased by the further addition of V2–V4 leads or by precordial mapping from multiple loci (16–72...
leads) on the chest wall [4, 7]. However, many operating-room ECG monitors still have only a three-electrode system which can be adapted so that similar precordial ECG information can be obtained by using modified bipolar standard limb leads. For example, the CM5 (central manubrium) lead is obtained by placing the negative (red) right arm electrode on the manubrium of the sternum, the positive (yellow) left arm electrode in the V5 position, and the ground (black) electrode in the left leg position. Lead I is then selected. Alternatively, a CB5 (central back) lead can be used by placing the right arm electrode over the center of the right scapula.

Accurate interpretation of the ECG – and in particular of the ST segment – requires the availability of a recorder. It is essential that the recorder is properly calibrated (1 mV = 10 mm) and that the ST segment is analysed at a sufficient paper speed (50 mm/s) 60 ms from the J-point. Changes in the ST segment indicative of ischemia may be evaluated visually or subjected to computer analysis.

In addition to recording the electrical potentials of the heart from the surface of the body, they may also be obtained from body cavities adjacent to the heart (i.e., esophagus and trachea) or from the heart itself (by using a multi-purpose balloon-tipped PA catheter with two pairs of electrodes for atrial and ventricular electrograms). Esophageal ECG monitoring has been demonstrated to be particularly helpful in detecting posterior myocardial ischemia usually not present in leads II and V5 [8].

**PA Catheter Monitoring**

The pulmonary artery catheter has been widely used in the operating room for almost 2 decades. Apart from the ability to obtain several measured and derived hemodynamic data the device can also be helpful in the early diagnosis of myocardial ischemia [9, 10]. Elevated PCWP and abnormal PCWP tracing (prominent a- and v-waves) frequently develop before the onset of ECG changes, or may represent the only sign of myocardial ischemia. However, Swan-Ganz catheters have raised major questions with regard to the benefit-to-hazard ratios, which are still unresolved [11–13].

To date there are no prospective, randomized, controlled studies which demonstrate improvement in perioperative morbidity or mortality as a direct result of PA-catheter monitoring in patients with CAD. Tuman et al. [45] have recently demonstrated that even high-risk patients undergoing coronary artery surgery may be safely managed without routine placement of a PA catheter.

**Echocardiography**

A promising use of echocardiography (preferably from the esophagus) is the detection of anesthesia-induced acute abnormalities of regional ventricular contraction which are highly sensitive and relatively specific indicators of myocardial ischemia [14, 15]. Although the superiority of echocardiography over electrocardiography for the detection of myocardial ischemia has been demonstrated [44], this technique suffers from the same problem as the ECG, because