USE OF THE PACING PULMONARY ARTERIAL CATHETER TO DETECT ENDOCARDIAL ELECTRICAL ACTIVITY DURING HYPOTHERMIC CARDIOPLEGIC ARREST

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ABSTRACT. The pacing Swan-Ganz catheter was evaluated for its ability to monitor atrial and ventricular electrical activity during cardioplegic arrest on cardiopulmonary bypass. This endocardial electrical activity was compared with the activity found on the standard electrocardiogram (ECG). The atrial electrodes detected activity that was noted also by visual inspection. The ventricular electrodes detected recurring electrical activity in 7 of 18 patients. Three of these 7 patients did not have simultaneous standard ECG activity, indicating that, in the usual monitoring circumstances, this ventricular electrical activity would not have been treated with repeat cardioplegia. If the pacing Swan-Ganz catheter is used for clinical care, it can be used also to monitor myocardial electrical activity during cardioplegic arrest.


Cardioplegic solutions protect the myocardium from intraoperative ischemia and depressed postoperative function by maintaining mechanical relaxation and electrical silence [1,2]. Monitoring cardioplegic effects usually consists of direct observation of the heart, observation of the standard electrocardiogram (ECG), and occasional use of myocardial temperature probes. The standard ECG may not adequately detect regional and global electrical activity compared with direct recordings from intramural or epicardial electrodes [3–5]. Although clinicians have used direct ventriculoelectrographic recordings, epicardial electrodes could interfere with the surgical procedure or could be withdrawn accidentally. We evaluated the Swan-Ganz flow-directed pacing TD catheter (American Edwards Laboratories, Santa Ana, CA) during hypothermic cardioplegic arrest to determine whether these intracardiac electrodes could be used to detect electrical activity and guide cardioplegic use.

METHODS AND MATERIALS

After institutional approval, 18 patients who were scheduled for elective valvular or coronary artery surgery consented to the study. These patients would have been monitored with a pulmonary arterial catheter, but were instead monitored with the Swan-Ganz pacing catheter (Model No. 93 205H-7F). This catheter has electrodes located 18.5, 19.5, 28.5, 31, and 33.5 cm from the tip. Intracardiac positions of the catheter's electrodes were assessed after sternal retraction by observing the recording of the bipolar atrial endocardial electrogram (AEG) and the bipolar ventricular endocardial electrogram (VEG) (Fig 1). The recording equipment
was electrically isolated with a leakage current of less than 10 μA. The simultaneously recorded AEG, VEG, and surface leads II and V5 were filtered at 300 Hz low-pass and 50 Hz high-pass. High-frequency filtering typically used for His bundle studies eliminates motion artifacts found at the standard ECG filtering frequency. We defined artifact as intermittent fibrillatory-like electrical activity related to the manipulation of the heart. This activity did not disappear with cardioplegic infusion. Recordings were made (1) during initial cardioplegic infusion into the aortic root, (2) just before and during cardioplegic delivery into each distal vein graft anastomosis, and (3) before and during repeat cardioplegic delivery into the aortic root.

The patients were followed postoperatively for 48 hours to determine the incidence of dysrhythmias and the need for inotropic support. Group differences were determined by chi square testing, with P < 0.05 the significant level. Inotropes, vasodilators, or both were used to maintain a cardiac index greater than 2.0 L/min/m² after rate, rhythm, conduction, and intravascular volume were optimized.

RESULTS

The AEG revealed easily discernible p-wave deflections in 13 of 18 patients, and the results for the AEG are based on these 13 patients. During cardioplegia, 7 patients had AEG activity that was always associated with obvious atrial muscular contraction (Fig 2). Five of these 7 patients received repeat cardioplegia, which temporarily silenced the AEG in 3 patients. Standard ECG activity never occurred without AEG activity. Two patients preoperatively in sinus rhythm experienced postoperative supraventricular dysrhythmias. Intraoperative AEG activity occurred in 1 of these 2 patients.

The VEG was technically adequate in all 18 patients. Cardioplegic delivery into the aortic root always provided electrical silence. Ventricular electrical activity recurred during cardioplegia in 7 of 18 patients as early as 12 minutes after aortic cross-clamping (Fig 3). In 3 of the 7 patients only the VEG was recorded, in 3 both the VEG and standard ECG were recorded, and in 1 only the standard ECG was recorded. These patients received silencing repeat doses of cardioplegic solution through a completed distal vein graft anastomosis. Four of the 7 patients with recurring ventricular electrical activity required inotropes. Seven (64%) of the 11 patients who did not have recurring ventricular activity required inotropes (chi square, P > 0.05).

DISCUSSION

The results suggest that the Swan-Ganz pacing catheter detects ventricular electrical activity during hypothermic cardioplegic arrest. The AEG recorded by the Swan-Ganz pacing catheter, however, provided information also obtained by visual inspection.

Persistent atrial and ventricular activities are associated with postoperative supraventricular conduction ab-