0090-3493/85/1311-0982$02.00/0
Critical Care Medicine

Vol. 13, No. 11
Printed in U.S.A.

brief report

Recording the right atrial electrogram through the fluid column of a pulmonary artery catheter

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Analysis of the cardiac rhythm in patients with ventricular and supraventricular tachycardia can be difficult because P-waves tend to be obscured by other components of the ECG. Recording of the intracavitary electrogram by means of pacing wires and the use of esophageal leads can be very helpful under these circumstances. Because a number of these patients are monitored with pulmonary artery catheters, we developed a method to obtain the atrial electrogram using the fluid column of the pulmonary artery catheter as an electrical conductor. Only slight modifications of the ECG equipment were necessary.

Hemodynamic complications in critically ill patients often coincide with atrial or ventricular tachyarrhythmias. Unfortunately, P-waves tend to be obscured by other components of the ECG during tachyarrhythmias, making ECG diagnosis difficult. We developed a method for recording a high-quality atrial electrogram (AEG) through the atrial infusion port (AIP) of a thermodilution catheter. This technique may be used for patients who already have a pulmonary catheter in place before they develop cardiac arrhythmias.

MATERIALS AND METHODS

Both a bipolar monitoring ECG lead from the body surface and an AEG were recorded in two patients. A conventional ECG patient cable (model 14067N, Hewlett-Packard) and two interconnected bioelectrical amplifiers (model 8811A, Hewlett-Packard) were used to record both ECG leads. Amplifier band width was set from 0.5 to 100 Hz, duplicating filter settings used in standard monitoring equipment. In order to further increase the quality of the signals, the amplifiers had a notch filter to reduce 50 cycle/sec interference. Signals were recorded on a two-channel strip-chart recorder (model 2200, Gould Medical, Inc). For patient safety, all equipment was checked for current leakage not exceeding a total of 10 μA.

This system was tested in two patients with an acute myocardial infarction. Each patient had previously undergone insertion of a pulmonary artery (PA) thermodilution catheter through the basilic vein of the left arm. One patient received a standard catheter (model 93-131-7F, American Edwards Laboratories, Santa Ana, CA), while the second patient received a PA catheter with an additional AIP 1 cm proximal to the standard AIP (model 93A-831-7.5F, American Edwards). In both patients the insertion procedure was uneventful and the correct position of the catheter with its tip in the right pulmonary artery was confirmed by chest x-ray.

In both patients, unipolar ECG recordings were made with the limb leads placed in their usual positions, and the V_1 terminal connected to the standard AIP with a sterile metal stopcock and an alligator clip. In the second patient, bipolar intra-atrial recordings were also obtained by connecting the V_1 and V_2 terminals to the standard AIP and to the additional AIP, respectively. Each atrial lumen was thoroughly flushed with isotonic saline (0.9% NaCl) to guarantee proper conduction of the electrical signals through the fluid columns. After flushing the catheter, the stopcocks were closed to prevent bacterial contamination.

Lead II of the standard ECG was recorded simultaneously with the AEG as a reference lead. At intervals, a 1-mV calibration signal was recorded to allow quantification of the electrical deflections. All recordings were made with the patients in the supine position.

RESULTS

Figure 1 shows the unipolar AEG obtained for patient 1 from the thermodilution catheter. The P/R ratio is higher than in standard lead II. P-wave amplitude is

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0.9 to 1.2 mV and QRS-complex amplitude is approximately 1 mV.

In the bipolar AEG (Fig. 2) obtained from patient 2, the various QRS complexes cannot be identified. The P-waves, however, can easily be seen. Their configuration changes somewhat during the respiratory cycle, with amplitudes varying between 0.3 and 0.8 mV.

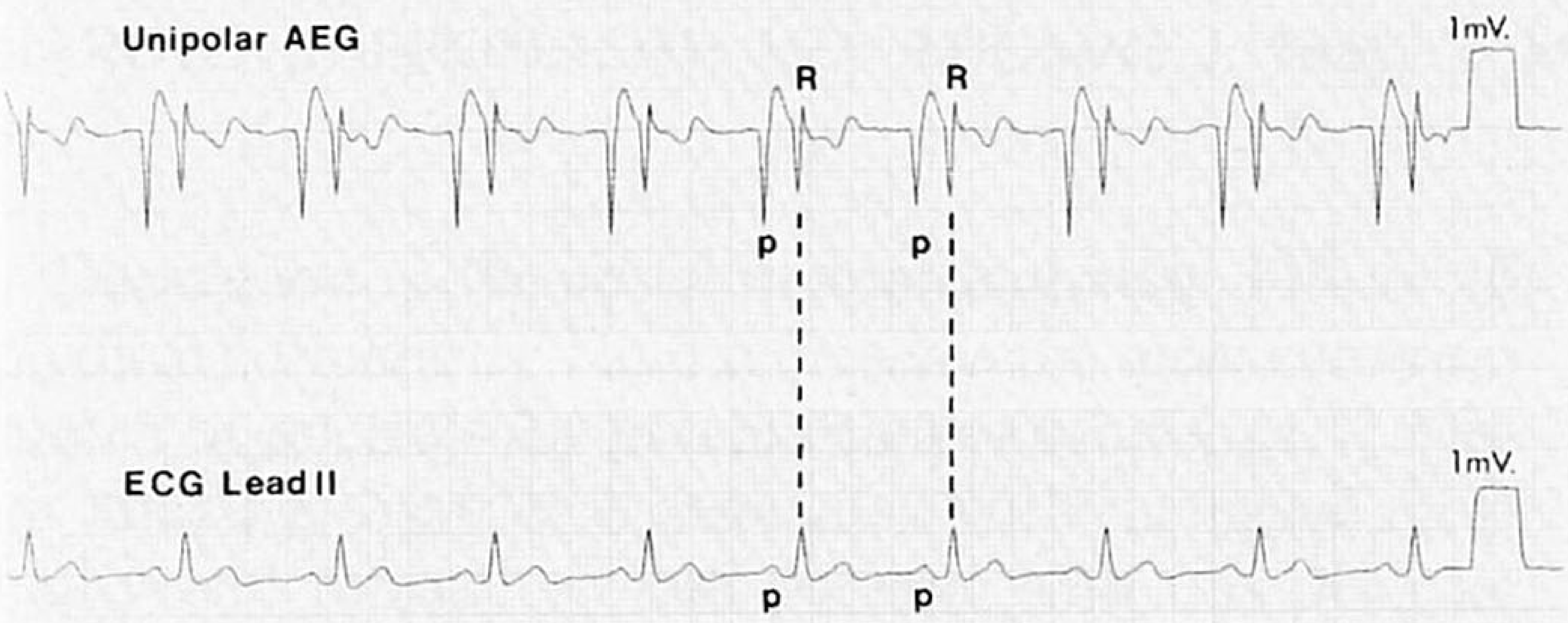

FIG. 1. Unipolar AEG and reference ECG lead II obtained from the first patient. *p* = P-wave; *R* = QRS complex.

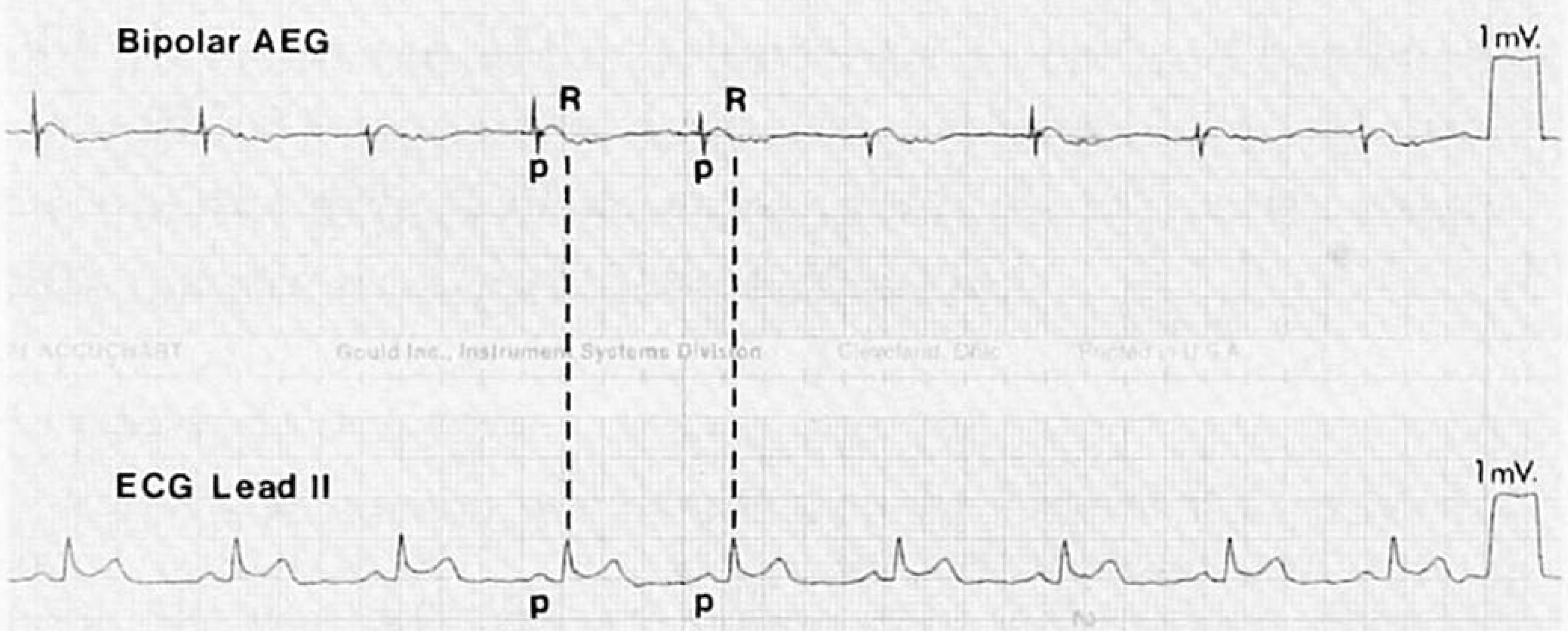

FIG. 2. Bipolar AEG and reference ECG lead II from the second patient. *p* = P-wave; *R* = QRS complex.

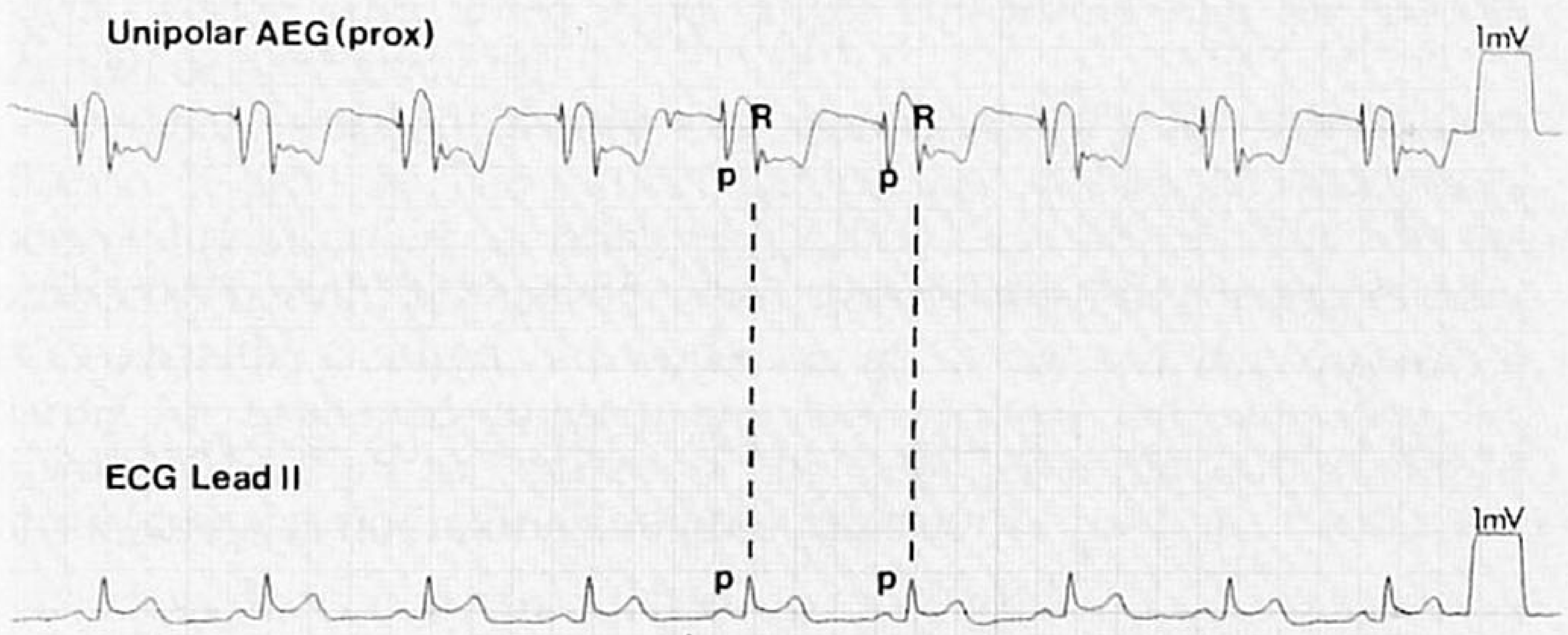

FIG. 3. Unipolar AEG from the standard AIP, and reference ECG lead II in the second patient. *p* = P-wave; *R* = QRS complex.

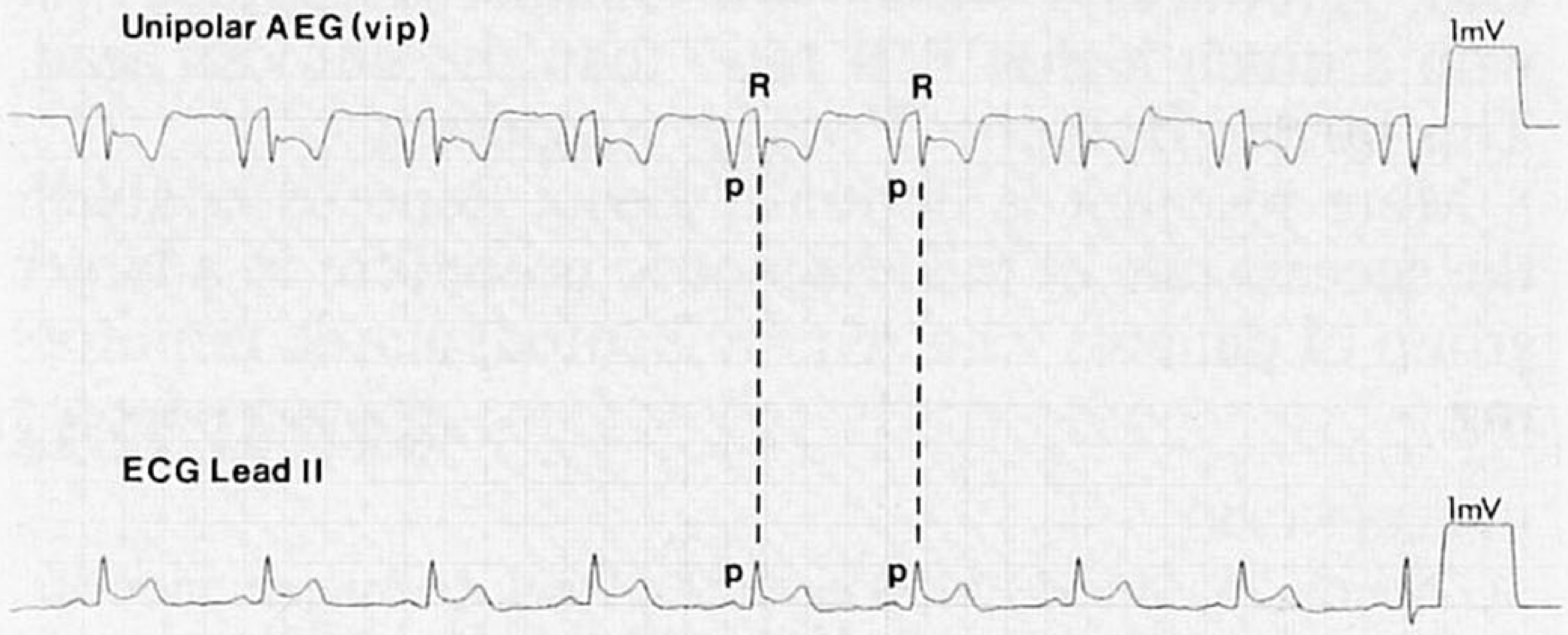

FIG. 4. Unipolar AEG from the additional AIP, and reference ECG lead II in the second patient. P-wave configuration differs slightly between Figures 3 and 4 because the AIPs are approximately 1 cm apart. *p* = P-wave; *R* = QRS complex.

Figures 3 and 4 show that unipolar AEGs for patient 2 have P/R ratios as high as those for patient 1.

DISCUSSION

In tachyarrhythmias, the recording of a good-quality AEG in which P-waves can easily be identified is of great diagnostic help to the attending physician. When the standard ECG does not supply sufficient information for interpretation of the arrhythmia, it may be necessary to insert an atrial pacing wire or an esophageal lead in order to get information on atrial electrical activity. Because these procedures are unpleasant for the patient, they should be avoided if possible. In patients requiring hemodynamic monitoring, a thermodilution catheter with additional pacing electrodes could routinely be used instead to obtain an AEG when necessary.[1] The routine use of these catheters, however, would substantially increase the cost of hemodynamic monitoring.

In 1961, Robertson et al.[2] described the recording of an AEG through the fluid column of a central venous catheter, using isotonic saline as an electrical conductor. Others[3] adopted this technique to identify the correct position of the catheter tip in the right atrium. An AEG of good quality could thus be obtained, comparable to AEGs using other methods[1,3] and to esophageal ECG recordings.[4]

We recorded an AEG of good quality through the fluid column of the standard thermodilution catheter. The electrical resistance of this fluid column is approximately 700,000 ohms, which makes it mandatory to use ECG amplifiers with a very high input impedance. In our experience it is relatively simple to obtain the desired results without manipulating the catheter or changing the patient's position.

The thermodilution catheter with an additional AIP can supply two different unipolar AEGs. More importantly, however, this type of catheter can be used to record a bipolar AEG which, like the bipolar esophageal lead,[5] produces P-waves with smaller amplitude but with a much higher P/R ratio than the unipolar lead. This further facilitates P-wave recognition.

More research is currently being done to establish the success rate of this diagnostic procedure in a larger group of patients who require hemodynamic monitoring.

REFERENCES

1. Mantle JA, Strand EM, Wixson SE: Atrial electrogram monitoring in a cardiac care unit. *Med Instrum* 1978; 12:289
2. Robertson JT, Schick RW, Morgan F, et al: Accurate placement of ventriculo-atrial shunt for hydrocephalus under electrocardiographic control. *J Neurosurg* 1961; 18:255
3. Martin JT: Neuroanesthetic adjuncts for patients in the sitting position III. Intravascular electrocardiography. *Anesth Analg* 1970; 49:793
4. Arzbaecher R: A pill electrode for the study of cardiac arrhythmia. *Med Instrum* 1978; 12:277
5. Hammill SC, Pritchett ELC: Simplified esophageal electrocardiography using bipolar recording leads. *Ann Intern Med* 1981; 95:18