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The Patient's Position Influences the Incidence of Dysrhythmias during Pulmonary Artery Catheterization

Donald J. Keusch, M.D., Stephen Winters, M.D.,† Daniel M. Thys, M.D.‡*

To determine the influence of a patient's position on the incidence of dysrhythmias during pulmonary artery catheterization, 34 adult patients scheduled for elective coronary artery bypass graft surgery and pulmonary artery catheterization were studied. All introducers were inserted *via* the right internal jugular vein using the Seldinger technique with the patient in the Trendelenburg position. For each patient, the pulmonary artery catheter was advanced twice: once while the patient was in the Trendelenburg (T) position with a 5–10° head-down tilt and another with a 5° head-up and right lateral tilt (R) position. In 13 of the 68 pulmonary artery catheter passages, no dysrhythmias were noted. In 13 patients, a change in dysrhythmia classification was noted between the two positions. In 11 of the 13 patients, the dysrhythmia classification changed from malignant in the Trendelenburg position to benign or absent in the right lateral tilt position. Although the incidence of dysrhythmias was similar in both groups, the Trendelenburg position was associated with a significantly higher incidence of malignant dysrhythmias than the right tilt position ($P < 0.05$). The authors conclude that the head-up and right lateral tilt position appears superior to the Trendelenburg position for passage of the pulmonary artery catheter in the awake patient scheduled for elective coronary bypass surgery. (Key words: Complications: dysrhythmias. Monitoring: pulmonary artery pressure. Position: cardiovascular effects.)

INSERTION of pulmonary artery (PA) catheters entails a number of risks.[1] Shah *et al.*[2] found that the most common complication associated with this procedure was the development of dysrhythmias, the majority of which were transient premature ventricular contractions not requiring pharmacologic treatment. However, fatal dysrhythmias such as ventricular tachycardia and ventricular fibrillation have also been reported.[3,4] In patients with impaired myocardial function or aortic stenosis, the onset of these dysrhythmias can lead to severe hemodynamic compromise.

Methods to decrease the incidence of dysrhythmias during PA catheterization have been explored. Lidocaine, for instance, has been tried prophylactically, but its use has yielded conflicting results.[5,6] The aim of the current study was to examine whether the position of the patient during flotation of the catheters could influence the incidence of dysrhythmias.

Methods

Thirty-four adult patients scheduled for elective coronary artery bypass graft surgery and PA catheterization were included in this investigation, which fulfilled the requirements of the Institutional Review Board. Written informed consent was obtained from each patient prior to the study. Patients with associated valvular heart disease and rhythms other than sinus were excluded. All patients were premedicated with a combination of morphine sulfate, scopolamine im, and/or a benzodiazepine orally. Their hearts were all in sinus rhythm on arrival in the operating room. After placement of ECG leads (II and V_5) and a radial arterial catheter, cannulation of the central venous circulation was begun. In all cases this was performed *via* the right internal jugular vein, using the Seldinger technique, with the patient in the Trendelenburg position. In an attempt to minimize the risk of venous air embolism, PA catheter introducers with self-sealing diaphragms were inserted while the patients were in this position. The 7.5-Fr thermodilution PA catheters (Model SP5507H®, Gould, Oxnard, California) were introduced by the anesthesiologists assigned to the cases.

The PA catheters were advanced, with inflated balloons and under pressure guidance, from the right atrium into the pulmonary capillary wedge (PCW) position while the patients were awake. For each patient the PA catheter was advanced twice: once while the patient was in the Trendelenburg (T) position with a 5–10° head-down tilt and once with the patient in a 5–10° head-up and right lateral tilt (R) position. The sequence of the positions was randomized, and the consistency of the positioning from patient to patient was estimated visually. Tracings of the ECG, the systemic arterial pressure, and the pressure measured at the tip of the PA catheter were recorded on paper as the catheters were advanced from the right atrium to the PCW position. The catheters were advanced at an approximate speed of 1.5 cm/s.

A cardiologist, blinded to the position of the patient during the PA catheterization, reviewed the ECG and pressure recordings and classified the dysrhythmias as absent, benign, or malignant. Benign dysrhythmias included atrial premature contractions, fusion beats, ventricular premature contractions, and accelerated idioventricular rhythms defined as three or more consecutive ventricular

* Assistant Professor of Anesthesiology.
† Assistant Professor of Medicine.
‡ Associate Professor of Anesthesiology.

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Address reprint requests to Dr. Thys: Department of Anesthesiology, Mount Sinai School of Medicine, One Gustave Levy Place, New York, New York 10029.

responses with a rate less than 120 beats/min. Malignant dysrhythmias included couplets and nonsustained ventricular tachycardia defined as three or more ventricular responses with a rate greater than 120 beats/min. For each patient two ECG and pressure recordings were obtained. They were individually labeled and analyzed independently. Rhythm tracings were assigned to the highest grade of ectopy. The time to advance the PA catheter from the right atrium to the PCW position was also recorded. Statistical analysis consisted of chi-square analysis and paired Student's *t* test. Differences were considered significant when a *P* value of less than 0.05 was obtained.

Results

A total of 68 catheter passages were performed in 34 patients. In 13 of the 68 PA catheter passages (19%) no dysrhythmias were noted. This was observed in five passages with the patient in the T position and in eight passages with the patient in the R position. In three patients catheter passage in the T position resulted in nonsustained ventricular tachycardia, with hypotension, before the PCW position had been reached. In each of these patients the dysrhythmia resolved when the catheter was withdrawn to the right atrium. Subsequently, the catheters were advanced to the PCW position with the patients in the R position.

In 13 patients a change in dysrhythmia classification was noted between the T and the R position. In 11 of the 13 patients (85%), the dysrhythmia classification changed from malignant in the T position to benign or absent in the R position (table 1). In the two other patients the reverse was noted. Although the incidence of dysrhythmias was similar in both groups, the T position was associated with a significantly higher incidence of malignant dysrhythmias than the R position ($P < 0.05$) (table 2).

The mean insertion time from the right atrium to the PCW position was 21 ± 10 s in the R position and 22 ± 10 s in the T position. The difference was not statistically significant. There were no complications related to the study, and all dysrhythmias resolved with withdrawal of the catheter to the right atrium or flotation to the PCW position.

Discussion

The results of this study demonstrate that the patient's position influences the incidence of malignant dysrhythmias during insertion of the PA catheter. When patients were placed in the R position, passage of the PA catheter was associated with a significantly lower incidence of malignant dysrhythmias.

Although the pulmonary artery catheter tip was originally designed to minimize the problem of mechanical irritation to the ventricular endocardium, dysrhythmias

TABLE 1. Changes in Dysrhythmia Classification Between Positions

Patient No.	R Position	T Position
1	Couplets*	APC
3	APC	Couplets*
5	PVC	Couplets*
6	PVC	Couplets*
7	PVC	Vent Tach*
14	PVC	Vent Tach*
17	Vent Tach*	PVC
19	Junct Prem	Couplets*
22	PVC	Vent Tach*
23	APC	Vent Tach*
27	APC	Couplets*
31	PVC	Couplets*
33	PVC	Couplets*

APC = atrial premature contractions; PVC = premature ventricular contractions; Vent Tach = Ventricular tachycardia; Junct Prem = junctional premature contractions.
* Dysrhythmias classified as malignant.

are still common during PA catheter insertion.[1-4] Persistent ventricular tachycardia, ventricular fibrillation, and even death have been reported during PA catheterization.[7-9] Particularly during myocardial ischemia the propensity for dysrhythmias appears high.[10] Sprung *et al.*[3] reported a 53% incidence of ventricular tachycardia during PA catheterization in critically ill patients. Although the significance of these malignant dysrhythmias has not been clearly established in the cardiac surgical population, they are often accompanied by transient hemodynamic disturbances that could be harmful.

Prophylactic lidocaine has been used in an attempt to reduce the incidence of dysrhythmias during passage of the PA catheter. Salmenperä *et al.*[5] demonstrated, in 107 cardiac surgical patients, that lidocaine 1 mg/kg, given iv 2–4 min before PA catheterization, did not decrease the incidence of dysrhythmias. With 2 mg/kg, they observed a clinically insignificant effect. However, the blood levels of lidocaine after a 2 mg/kg bolus were higher than normal antiarrhythmic levels. The need for such high lidocaine blood levels may in part be explained by the fact that dysrhythmias resulting from mechanical events are more resistant to lidocaine than those provoked by ischemia. In a different study, Shaw[6] found that 1 mg/kg of lidocaine can significantly decrease the incidence of dysrhythmias, provided that it is administered 3 min before advancing the catheter.

TABLE 2. Incidence of Dysrhythmias

Position	Benign Dysrhythmia	Malignant Dysrhythmia
R	18	8
T*	12	17

R = head-up with right lateral tilt position; T = Trendelenburg position.
* $P < 0.05$.

In the current study, we evaluated whether changes in position could reduce the catheter-induced mechanical irritation of the ventricular endocardium, as evidenced by a reduction in the incidence of dysrhythmias. A position was studied in which the right ventricular outflow tract was more superiorly located than the right ventricular apex.[11,12] It was compared to the T position, which is the position most commonly used for iv jugular vein cannulation and from which the PA catheter is often advanced in clinical practice.

The right ventricular outflow tract originates at the upper portion of the right ventricle and courses superiorly and to the left in most patients. When a patient is placed in the R position, the pulmonary valve becomes the most superiorly located structure in the right ventricle. This might allow the air-filled balloon to float promptly through the right ventricular outflow tract and into the pulmonary artery, reducing the contact between the catheter and the ventricular endocardium. Our results demonstrate that in this position the incidence of malignant dysrhythmias is indeed lower than when the patient is in the T position, although the exact mechanisms by which the lower incidence of malignant dysrhythmias was achieved could not be determined by this study.

The classification and definition of the dysrhythmias used in this study was based on work by Lown and Wolf.[13] Because each patient served as his or her own control, bias due to differences in populations was avoided and there were no obvious clinical differences between the patients who developed malignant dysrhythmias and those who did not. The use of continuous ECG paper recordings ensured that all dysrhythmias were detected. It has been suggested that if the PA catheter remained in the right ventricle for a prolonged period of time, the probability of developing dysrhythmias may increase.[3] In our patients, the duration of catheter insertion was equally brief for the two positions, eliminating the duration of flotation as a determinant of outcome.

Difficulties with catheter passage can be anticipated in patients with enlarged right ventricular cavities, pulmonary hypertension, or in the presence of low cardiac output.[4] In three of our patients the catheter could not be advanced to a PCW position when the patients were in the T position. They demonstrated repeated episodes of ventricular tachycardia, accompanied by hypotension. In the R position, catheter passage was expedient and uneventful. The head-up and right lateral tilt position did not result in any complication, such as hypotension, or clinically detectable, venous air embolism, in any of the 34 patients. We therefore suggest that this position be used for the passage of PA catheters in all awake patients. The R position should be particularly useful for patients who are expected to poorly tolerate malignant dysrhythmias. To reduce the risks of venous air embolism, introducers with self-sealing diaphragms should be inserted while the patients are still in the head-down position.

In summary, the influence of the patient's position on the incidence of dysrhythmias during PA catheterization was evaluated in 34 patients. Patients showed fewer malignant dysrhythmias during the passage of the PA catheter if they were in the head-up and right lateral tilt position. In three patients the catheter could not be advanced to the pulmonary capillary wedge position when the patients were in the T position. In 11 of 13 patients the dysrhythmia classification changed from malignant to benign when the position was changed from T to R. Therefore, the head-up and right lateral tilt position appears superior to the T position for passage of the PA catheter in the awake patient scheduled for elective coronary artery bypass surgery.

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