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Selected Topics: Emergency Radiology

ULTRASONOGRAPHIC GUIDANCE OF TRANSVENOUS PACEMAKER INSERTION IN THE EMERGENCY DEPARTMENT: A REPORT OF THREE CASES

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□ **Abstract—We report three cases in which ultrasound was used in the Emergency Department to facilitate the placement of a temporary transvenous cardiac pacemaker. © 1999 Elsevier Science Inc.**

□ **Keywords—echocardiography; transvenous pacing; ultrasonography; procedure; technique; pacemaker**

INTRODUCTION

Cardiac pacing can be achieved via transvenous, transcutaneous, or transesophageal methods. Indications for emergency cardiac pacing are evident in the hemodynamically unstable patient with bradycardia unresponsive to atropine, type II second-degree AV block, and third-degree AV heart block. These conditions are commonly seen in Emergency Department (ED) patients with acute myocardial infarction. Pacing also may be considered in patients with asystole, and in those with polymorphic ventricular tachycardias, such as torsades de pointes. Cardiac pacing will not reverse pulseless electrical activity or ventricular fibrillation, and should be avoided in hypothermic patients (1,2).

Transvenous pacing requires central venous cannulation under sterile technique. The pacemaker electrode is then placed either blindly or with electrocardiogram (ECG) guidance. In the former, the ECG or pulse is monitored for evidence of capturing. ECG guidance (the "current of injury" pattern when the distal end of the pacemaker lead touches the ventricular wall) is used when the patient has intrinsic cardiac electrical activity. Although fluoroscopy has demonstrated value as an adjunct to elective pacemaker insertion, its use in the ED is not possible. The success rate of emergent cardiac pacing without the aid of fluoroscopy ranges from 30%–90% (3,4).

Transcutaneous pacing, although used extensively in emergency medicine, may be unsuccessful in patients with increased thoracic impedance. Chronic obstructive pulmonary disease, obesity, pericardial or pleural effusion, pneumothorax, and the presence of cutaneous moisture and excessive hair all increase electrical resistance. In conscious patients, contraction of the thoracic wall musculature during transcutaneous pacing is painful (1). The capture rate in emergent transcutaneous pacing varies from 10%–93% (2,3).

Accepted indications for echocardiography in the ED include: diagnosis of cardiac tamponade (traumatic or nontraumatic), observation of electro-mechanical dissociation, and, in some centers, evaluation of aortic diameter for evidence of aortic dissection (5,6). The use of ultrasonography (US) in the ED for temporary cardiac pacemaker electrode placement, to our knowledge, has not been described. We report three cases of ED trans-

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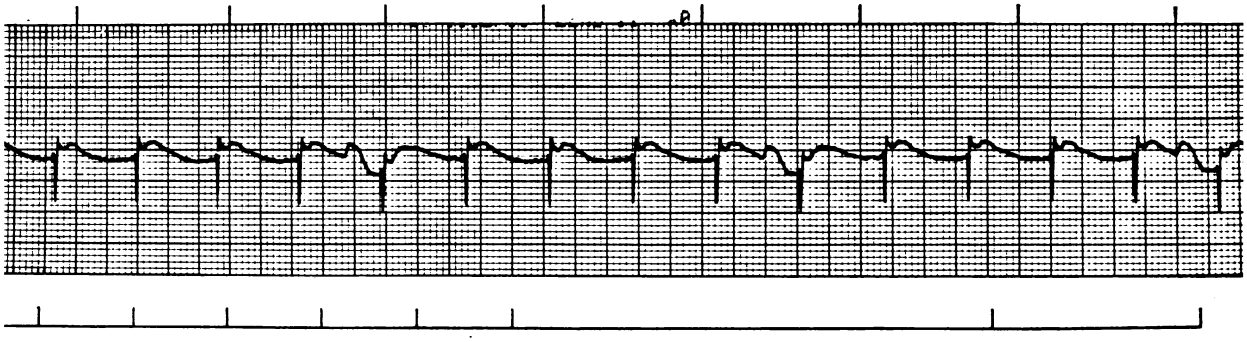

Figure 1. ECG tracing of patient #1 showing electrical capture.

venous pacemaker insertion, done with the aid of real time, continuous ultrasound (US) equipment.

MATERIALS AND METHODS

Temporary transvenous pacemakers were inserted in three patients. The pacemaker leads were advanced via right internal jugular access and guided by cardiac ultrasound as described below. Pacemaker equipment used in all cases consisted of a MedTronics, serial number 5375.

The US equipment used in all cases was a Sonoline Prima, manufactured by Siemens Medical Systems, Inc., Issaquah, WA, serial # BCA 0343, equipped with a 3.5MHz curved linear array scanner, 3.5 C/40S.

Of the four standard windows used for the cardiac examination in the ED (subcostal, left parasternal short and left parasternal long axis views, and the apical view), we used primarily the subcostal view. The subcostal window provides a good view of the four cardiac chambers, mechanical activity, presence of pericardial fluid, and gross assessment of wall motion. In addition, the subcostal view is obtained with the patient in a supine position, while the other views require a lateral decubitus position. Methods used in the individual cases are further described below.

Case 1

A 29-year-old male with a history of sickle cell anemia presented to the ED with shortness of breath. The patient was diaphoretic and in severe respiratory distress. The blood pressure was 154/92 mmHg, pulse 122 beats per minute, respiration 28 breaths per minute, and rectal temperature 38.3°C. There were extensive rales on auscultation bilaterally. Heart sounds were normal. A portable chest X-ray study showed an enlarged heart, and the lung field image was suggestive of pulmonary edema. Pulse oximetry was 92% on facial mask, with an FiO_2 of 100%. The patient was treated for pulmonary edema with furosemide 60 mg intravenously (i.v.) and nitroglycerin 0.4 mg sublingual. Ceftriaxone 2.0 gm. was given i.v. after blood cultures were drawn, for possible pneumonia. About 45 min after arrival, his condition deteriorated, eventually necessitating endotracheal intubation. During intubation, the patient suffered cardiac arrest. He was found to be in asystole by ECG monitor. External pacing was attempted, but ventricular capture was not achieved. The decision was then made to insert a transvenous pacemaker "blindly" via the right internal jugular vein. Ultrasonography was used to assess myocardial activity and pacemaker lead position. The tip of the electrode was visualized by US passing from the right atrium to the right ventricle. The electrode touched the ventricular apex, and electrical capture was noted on the ECG monitor (Figure 1), but there was no mechanical activity of the myocardium. The electro-mechanical dissociation was refractory to further therapy, and the patient was declared dead 35 min after cardiopulmonary resuscitation was initiated.

Case 2

A 65-year-old woman presented with a complaint of generalized weakness. Although initially not known, it was later ascertained that she was taking propranolol for hypertension. The initial physical examination showed an obese, lethargic woman with a systolic blood pressure of 84 mmHg, a pulse of 52 beats per minute, respiration of 20 breaths per minute and a rectal temperature of 37°C. A 12-lead ECG showed a type II second-degree AV heart block (Figure 2A). The patient was continuously monitored, and a transvenous pacemaker wire (chosen because the patient's obesity made her an un-

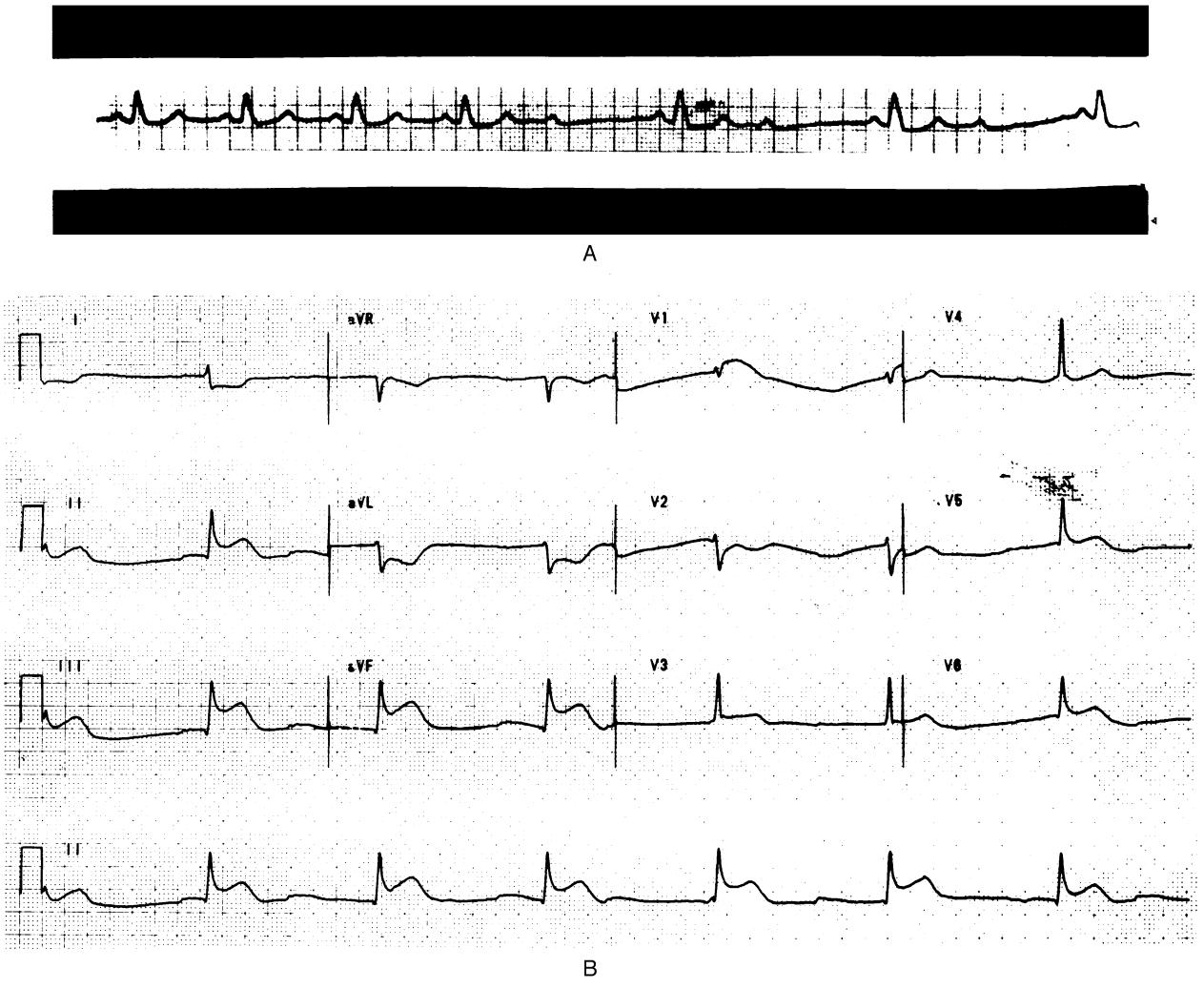

Figure 2. In A, Second Degree Type II Atrio-Ventricular Heart Block in patient #2. In B, Third Degree A-V Block with wide QRS complex and ST elevation observed in leads II, III, and AVF of patient #3.

suitable candidate for transcutaneous pacing) was inserted via the right internal jugular vein with the help of cardiac ultrasound. The subcostal window was used to localize the tip of the pacer wire. It was visualized passing the tricuspid annulus, and the balloon was deflated. The wire tip reached the ventricular apex, capture was noted, and the patient's systolic blood pressure increased to $>$ 100 mmHg, with concurrent improvement of her lethargy. Propranolol was withheld, her cardiac rhythm returned to normal sinus, and temporary pacing was no longer necessary. Cardiac enzymes were normal, and the ECG did not evolve any changes. The patient was discharged 3 days after admission. A diagnosis of propranolol toxicity was not initially considered because the patient was not known to be taking propranolol at the time of presentation to the ED.

Case 3

A 65-year-old mildly obese female arrived by ambulance in cardiac arrest. Upon arrival in the ED, she was intubated. After intubation, a wide complex tachycardia with a pulse of 138 beats per minute was observed on the ECG monitor. Lidocaine 70 mg was given i.v. The patient's rhythm then changed to asystole alternating with periods of ventricular dysrhythmia. Bretyllium 350 mg was given i.v. times two, followed by a 1 mg/min i.v. infusion. The patient regained an arterial pulse, and a third-degree AV block with a wide QRS complex was noted on the ECG, along with ST elevation in the inferior leads (Figure 2B). Because of the patient's obesity and anticipated difficulty with transcutaneous pacing, the decision was made to insert a temporary transvenous pacemaker.

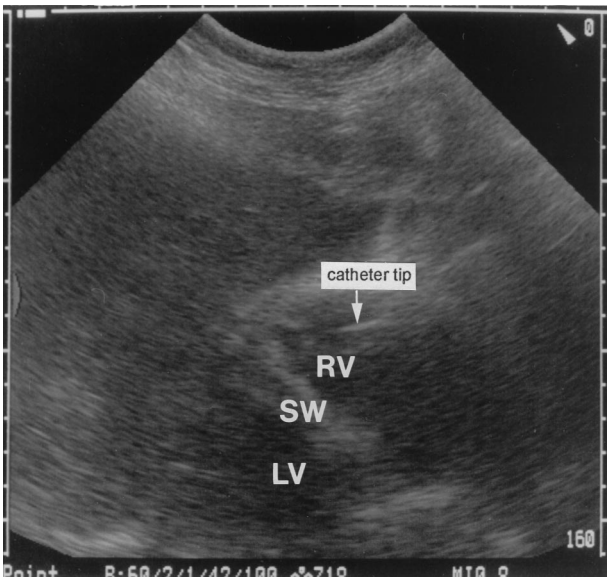

Figure 3. Subcostal view with visualization of the catheter tip in the right ventricular cavity. RV: Right Ventricular Cavity; SW: Septal Wall; LV: Left Ventricular Cavity.

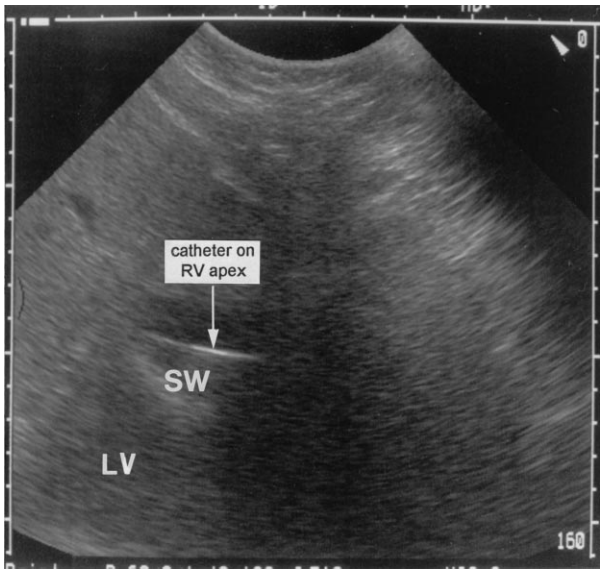

Figure 4. Electrode (catheter tip) placed in right ventricular apex. SW: Septal Wall; LV: Left Ventricular Cavity.

Intravenous access was obtained via the right internal jugular approach, and the negative electrode was connected to a cardiac monitor for continuous ECG recording. Ultrasonography was utilized to assist with pacemaker lead insertion via the subcostal view. Initially, we were unsuccessful in obtaining a "current of injury" pattern while the tip of the electrode was visualized in the right ventricular (RV) cavity (Figure 3). When the electrode was advanced and placed in the RV apex (Figure 4), the "current of injury" pattern was observed on the ECG (Figure 5). The lead was connected to the pacemaker and 1:1 electronic capture was observed (Figure 6) with a return of a palpable pulse and a blood pressure of 92/54 mmHg. The patient was stabilized and admitted to the coronary care unit but died 24 h later.

DISCUSSION

We have presented three cases in which we used cardiac ultrasonography in the ED during placement of trans-

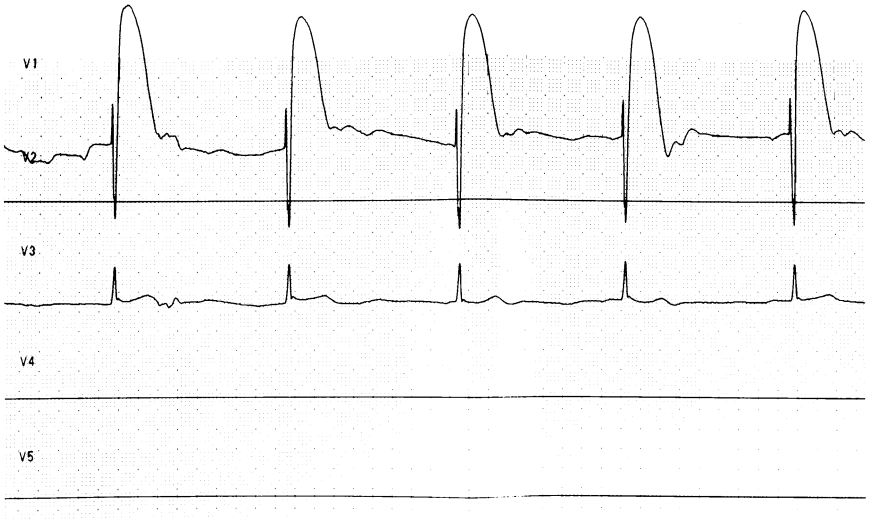

Figure 5. "Current of Injury" pattern with the electrode placed in right ventricular apex.

Figure 6. Demand pacing with 1:1 capture at 80 beats per minute.

venous electronic pacemaker wires. While fluoroscopy has been shown to be a valuable adjunct for transvenous pacemaker placement, ultrasonography is more practically available in many EDs.

Advantages of echocardiography over fluoroscopy in cardiac diagnostic procedures and the use of Doppler flow detection in identifying the lateral subclavian/axillary veins for extrathoracic pacemaker lead placement have been described (7,8). Jesus et al. described placing temporary cardiac pacemakers using echocardiography in 20 patients in the Department of Cardiology of Distrital Hospital in Faro, Portugal (9). Nanda and Barold extensively studied the use of two-dimension echocardiography in localizing, repositioning, and assessing the functional status of electrodes in the cardiac chambers, as well as identifying complications of pacing catheter placement (10). Drinkovic suggested the subcostal view as the preferred view for catheter placement in electrophysiologic studies, and Guldal et al. utilized two-dimension echocardiograpy in a pregnant woman for permanent pacemaker implantation (11,12).

It may be anticipated that overly expanded lungs, as seen in patients with COPD, might interfere with the ultrasonographic visualization of the right ventricle, and that the catheter tip also may be difficult to visualize in hearts with very large chambers (10). In our experience with three cases of ED transvenous pacemaker insertion guided by ultrasonography, we did not recognize any complications attributable to the use of ultrasonography. Although the outcome for the patient in case number 1 was unfavorable, the procedure itself was successful as evidenced by ventricular capture noted on the ECG tracing. In this case, ultrasound was also able to establish a definitive diagnosis of electromechanical dissociation.

We believe that cardiac ultrasonography can be a valuable adjunct to the placement of transvenous cardiac pacemakers in the ED setting. Prospective studies may identify the success rate of this adjunct, as well as possible complications. In addition, it may be important to identify whether ultrasonography has an effect on the time required for successful transvenous pacemaker insertion for emergent indications.

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