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Emergency Transvenous Cardiac Pacing

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A single pacemaker electrode catheter placement procedure, using the subclavian route and a semi-floating pacemaker catheter, was utilized in 120 consecutive patients who required emergency cardiac pacing. Stable pacing was achieved in a high percentage with few complications.

Introduction

EMERGENCY transvenous cardiac pacing can be performed at the bedside. Patients requiring this procedure are often too ill to be moved to X-ray facilities or cardiac catheterization laboratories, while portable image intensification equipment is expensive and generally not available in the average community hospital.

This report describes my experience with a single pacemaker catheter placement procedure, using the subclavian route and a semi-floating pacemaker catheter, in 120 consecutive patients who needed emergency pacing.

Materials and Methods

From 1972 to 1977, 120 consecutive patients, ranging in age from 15 to 94 years old (Table I), required the insertion of 123 temporary, endocardial pacing catheters in an emergency situation. All procedures were performed at the bedside following a well-outlined format.[1,2] A small diameter (French 4), bipolar, semi-floating, pacing catheter* was passed through a teflon sheath** adequately placed in the subclavian vein. The catheter was then advanced with EKG guidance into the right ventricle and manipulated until the most satisfactory position was achieved. The adequacy of the final position required the recording of a current of injury from the catheter tip, consistent ventricular pacing at a threshold of less than 1.0 mamp (in most cases .5 mamp was achieved), and assurance of adequate sensing of the demand pacemaker, with no detectable evidence of competition. A surface electrocardiogram (EKG) was then taken, the morphology of the pacer-induced complex being used to judge the site of ventricular stimulation. The goal of the pacemaker catheter placement was a pattern suggesting right ventricular apical pacing, namely left bundle branch block with left axis deviation. In cases where the immediate

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* Usually of the Cordis® variety

** Angiocath or Jelco®

TABLE I

AGE AND SEX OF STUDY PATIENTS

AGE	MALE	FEMALE
10-20		1
21-30	2	
31-40	2	
41-50	6	4
51-60	20	
61-70	28	12
71-80	19	14
81-90	6	4
91-99	1	1
TOTAL	84	36

need for pacing did not allow for further catheter manipulations, other right ventricular positions were acceptable.

The point of penetration of the skin by the teflon sheath was dressed with an antibiotic ointment. Systemic antibiotics were not used. To insure its stability, the exposed catheter was anchored in placed with tape, which was applied so as to allow adequate shoulder movement without undue stress on the catheter placement site. Dressings were changed at least every 72 hours, and new antibiotic ointment was applied.

In all cases, a QRS-inhibited external pulse generator (medtronic 5880A or earlier model) was used, secured to the chest or arm. The final current was set sufficiently above the threshold of cardiac response and adjusted as necessary. Most procedures could be performed in less than 15 minutes. For varying reasons, a few required more than 20 minutes, with a rare insertion requiring one to two hours. Afterwards, portable chest X-ray films were obtained to verify catheter position. As the pacemaker catheter was removed, lidocaine, 50 to 75 mg, was given intravenously before the catheter tip was actually dislodged.

Results

Table II lists the five clinical situations which required emergency, pacemaker catheter placement. Of the 120 patients requiring 123 temporary, pacemaker catheter insertions, 57 (48%) died. Autopsies performed on 32 helped to verify the diagnosis.

Cardiac Arrest

Pacemaker catheters were placed in 29 (24%) patients suffering from cardiac arrest (Cor Zero) (Table III). The procedure was performed during closed chest, cardiopulmonary resuscitation or a short time later. All patients were without or with barely detectable blood pressures and had associated problems such as congestive heart failure, recurrent or drug resistant ventricular tachycardia, electrolyte imbalance or acidosis complications, renal failure, and aspiration pneumonia. Pacemaker catheter placement was undertaken because of some EKG evidence of return of ventricular activity at inadequate or ineffective rates.

In nine (31%) patients it was impossible to determine if there was adequate pacing catheter placement, although in two of the nine there was brief capture of the ventricles suggesting adequate placement. In 20 (69%) patients there was adequate placement with pacing achieved for periods of a few hours up to as long as four days. Of the 20, only one left the hospital alive. One patient died 17 days after effective pacemaker treatment from other complications.

Acute Myocardial Infarction

The largest group of patients requiring emergency, temporary pacemaker catheter placement had complicated acute

TABLE II

CLINICAL SITUATIONS REQUIRING PACEMAKER CATHETER

	PROBLEM	PATIENTS	PATIENTS RESPONDING TO PACING EFFORTS	SURVIVORS
I	CARDIAC ARREST	29 (24%)	20	1
II	ACUTE MYOCARDIAL INFARCTION	51 (43%)	49	29
III	SICK SINUS SYNDROME	29 (24%)	29	24
IV	CORONARY ARTERY DISEASE WITH ADVANCED A-V HEART BLOCK	5 (4%)	5	4
V	OTHER	6 (5%)	5	5
	TOTAL	120	108 (90%)	63 (52%)

TABLE III

CARDIAC ARREST PATIENTS

CONDITION	PATIENTS	SUGGESTED ADEQUATE CATHETER PLACEMENT	PATIENTS LEAVING HOSPITAL
ACUTE MI WITH COMPLETE HEART BLOCK	15	10	1
ACUTE MI WITH LESSER DEGREE OF BLOCK	4	3	0
MASSIVE PULMONARY EMBOLUS	4	3	0
OTHER*	6	4	0
TOTAL	29	20	1

* Including malignant hyperthermia, intracranial catastrophes, severe hyperkalemia, Wegener's granulomatosis, and terminal complications of rheumatic heart disease.

myocardial infarctions (Group II). Most demonstrated some form of high grade A-V heart block; many had cardiogenic shock; and a few had only mild hypotension related to volume deficits. The patients in this category were divided into groups based on the type of myocardial infarction because of the marked variation in the prognosis and complications associated with the specific site of the infarction. Patients with inferior wall myocardial infarction associated with complete A-V heart block were considered candidates for pacing when the heart rate slowed to 45 or below, was unresponsive or responded adversely to atropine, was accompanied by ventricular irritability, or when the medical record or old EKG suggested a previous myocardial infarction. Almost three-fourths of the patients with anterior myocardial infarctions had complete heart block; the others had high grade A-V heart block. In these patients, overdrive pacing was occasionally used to treat otherwise resistant ventricular tachycardia that developed during the postinfarction period.

Of the 51 patients in Group II, 29 were alive at least one month after leaving the hospital. The survivors included 8 of 23 (35%) with anterior infarctions, 17 of 20 (85%) with inferior infarctions, and 3 of 7 (43%) with true posterior infarctions. One patient with an extensive subendocardial myocardial infarction complicated by complete heart block and cardiogenic shock required pacing for seven days but stabilized and did well.

In this group, good initial catheter placement and adequate pacing were achieved in all but two cases. One patient responded only to stimuli transmitted by a surgically-placed epicardial lead. In the second, catheter placement was unsuccessful because the myocardial infarction was complicated by complete heart block and a massive (saddle) pulmonary embolus found at autopsy.

Sick Sinus Syndrome

Emergency temporary pacing was performed in 29 (24%) patients with the sick sinus syndrome (Table IV). In patients with myocardial infarctions and this syndrome, brady or tachyarrythmias that were symptomatic (congestive heart failure, hypotension, etc.) were treated with temporary pacing and appropriate drugs. In others who were symptomatic during evaluation, where drug toxicity or a transcient process appeared possible, temporary pacing was utilized.

TABLE IV

PATIENTS WITH SICK SINUS SYNDROME

CAUSE	PATIENTS	ADAMS-STOKES EPISODES	REQUIRED PERMANENT PACEMAKER	SURVIVORS
ACUTE MI	7	1	0	2
CORONARY ARTERY DISEASE	14	6	9	14
UNKNOWN	5	1	4	5
OTHER	3	0	0	3
TOTAL	29	8	13	24

In two patients, the pacing catheter could not be directed into the right ventricle; however, effective atrial pacing was fortuitously accomplished in both cases for one and three days respectively. In three patients, effective pacing was lost within two days; two of these required repositioning of the catheter tip, and one required placement of a second catheter.

Coronary artery disease with advanced A-V block

In the fourth category, five (4%) patients, 70 to 93 years of age (all thought to have coronary artery disease), presented with symptons related to the development of high grade A-V heart block. Three has Adams-Stokes episodes. Four had complete heart block, one of whom responded to atropine with bursts of ventricular tachycardia. Three of the five needed permanent pacemakers; two patients required repositioning of the temporary catheter within two days; however, none required placement of a new temporary pacing catheter.

Other illnesses requiring pacing

The fifth category includes six (5%) patients with a variety of major illnesses associated with severe cardiac disease. In three, the cardiac disease was complicated by the presence of digitalis and/or quinidine toxicity. Three had Adams-Stokes episodes just before the therapeutic efforts. One patient in this group had pacemaker catheter placement to control resistant ventricular tachycardia by overdrive pacing. After inital success, the pacemaker catheter tip became dislodged the following day. A second cathether was placed but with similar loss of pacing. Efforts at stable catheter placement by a thoracic surgeon utilizing fluoroscopy were likewise unsuccessful, and the patient died.

Since fluoroscopy was not used to guide the pacemaker electrodes into position, surface electrocardiographic evidence of adequate initial positioning of the electrode tip was relied upon. EKG patterns suggesting right ventricular apical pacing were recorded in 70 (58%) patients with other right ventricular positions recorded in 31 (26%). In 19 (16%) patients, EKG localization of the electrode tip was not obtained, could not be determined, or right ventricular positioning was not achieved.

In the 91 patients in Groups II-V, pacing electrodes were used for 410 days, for an average of 4.5 days per patient. Pacing electrodes were kept in place for periods of less than an hour up to 15 days.

Complications

Few complications were related to the introduction of the electrode catheters. One patient developed a small, uncomplicated pneumothorax. Three developed transient, premature, ventricular contractions when the electrodes were inserted. Another patient developed a supraventricular tachyarrythmia which subsided spontaneously. Still another developed transient, premature, ventricular contractions when the electrodes were removed, despite lidocaine prophylaxis.

Complications after insertion of the catheter electrodes were as follows. In ten (8%) patients effective pacing was lost within two days, although in eight of these ten it was corrected by early repositioning, later replacement of the electrode catheter, or by increasing the voltage output of the pacemaker. In two cases, the loss of pacing contributed to the clinical deterioration in the patient. Another patient had late electrode tip displacement but no further need for the pacing catheter. In three patients, the pacing electrode could not be directed into the right ventricle, or would not remain lodged in the location. In two of these cases, both with the sick sinus syndrome, atrial pacing was accomplished by the fortuitous placement of an atrial lead. In the third patient, stable atrial pacing was achieved by passing the electrode through a persistent left superior vena cava, through an enlarged coronary sinus, and into the right atrium.

Prior to pacemaker catheter placement, fever was present in seven patients, and was due to multiple etiologies such as malignant hyperthermia, pneumonias, bronchitis, and urinary tract infections. No new temperature elevations were noted. No infections were related to the electrode catheter or the catheter placement procedure.

Discussion

Between October, 1972 and July, 1977, 123 temporary transvenous pacemaker electrode catheters were introduced into 120 patients. There were 77 cases of acute myocardial infarctions with 64 instances of complete heart block and 21 Adams-Stokes episodes.

The largest group was those with acute myocardial infarctions complicated by heart block. The mortality in this group is generally considered to depend on the size and location of the infarct. In our study, the size (as indirectly suggested by the number and nature of associated complications) and the location proved to be important prognostic factors. Chatterjee et al[3] state that early insertion of a demand pacing system is desirable in order to avoid syncope (associated with a high mortality in their patients). They note that when necessary safeguards are employed, the disadvantages of pacing are slight, and that only when a pacing system has been installed is it safe to use antiarrythmic drugs.

The second group of patients requiring temporary pacing was those with the sick sinus syndrome. Twenty-seven of the 135 patients in the series of Widmann et al[4] required introduction of a temporary pacemaker electrode for that complication. A temporary pacemaker often allowed more time to safely evaluate new patients who were usually symptomatic, often taking unknown drugs in unknown dosages, and whose presenting clinical picture was potentially transient. The use of a temporary pacemaker in this setting could possibly spare the patient the need for a permanent pacemaker, as appears to have been the case in this series.

In the cardiac arrest patient, who represents the ultimate emergency, effective temporary pacing is more difficult to achieve and maintain. The myocardium may be incapable of responding to adequate stimulus even if the myocardial environment is not hindered by acid-base disturbances, hypoxia, electrolyte imbalances, etc. Nevertheless, it is difficult to refrain from an effort to establish effective pacing when a patient who appears to have no brain damage responds to cardiac resuscitation with a heart block pattern on the electrocardiogram.

These clinical situations emphasize the need for a rapid, effective, and safe bedside approach to cardiac pacing in critically ill patients. This need arises frequently in smaller hospitals which are remote from medical centers and are often without cardiac catheterization laboratories or portable image intensification equipment.

Subclavian vein puncture has proved to be a safe and rapid procedure[5,6] for achieving effective pacing. Rosenberg et al[2] reported only three complications in 106 veinpunctures. The subclavian route allows the patient freer use of his arms and legs than would be possible with certain other routes. The brachial vein route, as Furman noted,[7] is associated with a high incidence of electrode displacement due to arm motion, while the femoral vein route generally takes longer and limits the patient's ambulation. Widmann et al[4] have outlined the problems associated with the external jugular approach. Lau[8] expressed concern about the brisk bleeding of the internal jugular vein were it to be lacerated, although Widmann et al[4] reported few complications with this approach. However, the subclavian approach, while rapid and effective, is not without complications in inexperienced hands. It should not be used by those uncertain of the technique, unfamiliar with the anatomy, or unaware of the potential complications.

The combination of the subclavian route and a semi-floating pacing catheter produced a high percentage of stable pacing cases in this series. Furman[7] reported that, without fluoroscopy, he was able to achieve stable pacing in about 80% of his patients using a floating catheter and the subclavian route. Late displacement of the electrode was less common in our patients than in those of Furman, who noted 17% in his series,[7] because we tended to remove the pacing catheter early. It was often removed after three days if the monitoring devices and the patient's clinical picture indicated no further need for it. A physician experienced in the procedure is more likely to remove the catheter early since he is confident of his ability to reestablish pacing should it be required again. In spite of the method of placement, electrode dislodgement continues to be a problem. High incidences requiring repositioning of the catheter tip or replacement were noted, even when the catheter insertions were performed in the cardiac catheterization laboratory.[9]

Conclusion

The capability of the procedure described in this report to provide stable, effective, and rapid pacing over the period of greatest need is suggested from the 120 cases reviewed. Complications from this procedure should be minimal, when performed by those skilled in its use. It is especially suited to the emergency setting, though equally effective in less critical situations as well. This approach to temporary pacing would appear to be particularly valuable in hospitals where cardiac catheterization laboratories and portable image intensification equipment are not available.

Acknowledgment

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