Reassessment of the Natural Evolution and Complications of Temporary Epicardial Wires After Cardiac Surgery

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Objective: **The aim of this study was to prospectively reassess the natural evolution and complications of temporary epicardial wires (TEW) after cardiac surgery.**

Design: **Observational prospective study.**

Setting: **Monocentric.**

Participants: **All adult patients having cardiac surgery with TEW insertion, except for those undergoing cardiac transplantation or having permanent pacemakers.**

Interventions: **Thresholds were measured daily until wire removal or permanent device insertion. Descriptive statistics and analysis of variance (ANOVA) were performed with $p < 0.05$ as the significance threshold.**

Main results: **Two hundred thirty-six patients were enrolled. All had ventricular and only 142 (60%) both ventricular and atrial unipolar FEP15, Ethicon TEW. In most TEW (74%), capture thresholds increased significantly by the first (atrial wires) and by the second (ventricular wires) postoperative day and continued to increase until the fifth day, followed by a plateau. For the others, 2 opposite profiles were noticed: 10% of the total TEW lost their capture function before the fourth postoperative day, whereas 16% remained functional beyond the seventh postoperative day. Both atrial and ventricular sensitivity degraded significantly by the second day. The median energy output used for pacing was 17.5 mA (atrial) and 20 mA (ventricular), regardless of the capture thresholds. Major complications related to TEW were noted in 0.8% of cases.**

Conclusion: **Despite widespread use, the natural history of TEW is still a major concern. Pacing with high-energy output is a possible factor leading to capture dysfunction that must be avoided. Education of all operators is needed.**

KEY WORDS: temporary epicardial wires, temporary pacing, cardiac surgery, thresholds, complications

INTRODUCTION

CARDIAC SURGERY with or without cardiopulmonary bypass (CPB) provides frequent conduction and rhythm disturbances, especially during the immediate postoperative period. Their etiology is multifactorial: Surgical manipulation, myocardial edema, hypothermia, heterogenous washout of cardioplegia solution during CPB, and acid-base and blood gas disorders, along with eventual inotropic drug support.[1] Temporary epicardial pacing by means of temporary epicardial wires (TEW) appears to be the best and simplest method for treating rhythm and conduction disturbances after cardiac surgery. In addition, temporary epicardial pacing also is used increasingly to improve cardiac output, by optimal pacing mode or rate[1,2] or by means of biventricular pacing in cases of severe left ventricular systolic dysfunction.[3,4]

Complications related to TEW occur occasionally on TEW removal (0.04% in one study[5]). They can be dangerous and include tamponade, hemothorax, disruption of coronary anastomoses, and migration of retained wires.[6–8] But the major concern of TEW is the natural evolution of their thresholds. In 2002, Elmi et al reported, in a cohort of 60 consecutive patients, a significant elevation of capture thresholds after the fourth postoperative day and significant deterioration of sensitivity after the second postoperative day[9] with no predictive factors identified. This evolution, related to the inflammatory reaction around the wire–myocardium interface,[6] seems to be accepted universally, but there are no recent larger studies on this subject. In addition, the authors' clinical observations suggested that the deterioration of capture/sensitivity thresholds might be worse than that described by Elmi et al.

In this context, the main aim of this study was to prospectively reassess the natural evolution of TEW thresholds in a single institution. The second aim was to describe the frequency of complications related to TEW.

MATERIALS AND METHODS

The authors conducted an observational, prospective, monocentric study between December 2011 and April 2012 in a university hospital. The Institutional Review Board of the hospital approved this study and waived the requirement for written informed consent. All adult patients (>18 years) having cardiac surgery with TEW insertion were included consecutively, except for those undergoing cardiac transplantation or having permanent pacemakers. Standard unipolar FEP15 Ethicon® TEW (Johnson & Johnson, Somerville, NJ) were implanted by surgeons according to their personal technique. Seven surgeons of this unit were responsible for inserting TEW. One of them always placed the positive electrode in the subcutaneous tissues, whereas the others either placed one electrode on the epicardium and the other on the pericardium or both of them on the epicardium according to the circumstances (quality of tissues, dependence on pacing, personal preference, etc.)

The following variables were collected prospectively for all patients : (1) preoperative: age, gender, body mass index (BMI), medical history, American Society of Anesthesiologists (ASA) score, EuroSCORE 1 and 2 values, electrocardiographic data (preoperative rhythm and conduction disorders), echocardiographic data (left ventricular ejection fraction [LVEF], LV dilation or hypertrophy, left atrial dilation, systolic arterial pulmonary pressure [sPAP]), laboratory tests results (white blood cells

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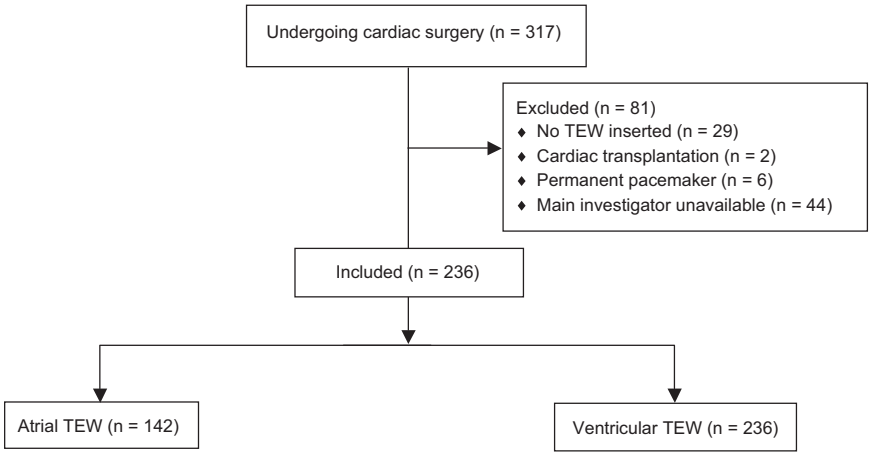

Fig 1. Flow diagram.

[WBC], platelets, C-reactive protein [CRP], fibrinogen, creatinine, glucose), and treatment (antiarrhythmic and inotropic drugs); (2) intraoperative: surgery characteristics (type, emergency, reoperation, CPB and aortic cross-clamp time, cold/warm anterograde/retrograde cardioplegia), TEW insertion site, temporary pacing settings and catecholamines used for weaning from CPB, and TEW thresholds; (3) postoperative: number of days until TEW removal or permanent device insertion, underlying rhythm, TEW thresholds, TEW dysfunctions (failure to pace/to capture/to sense), laboratory tests results, and treatments.

Thresholds were measured on arrival in the intensive care unit (ICU) and then daily until wire removal or insertion of a permanent device. The measures were performed by the same operator with a Medtronic® 5388 (Medtronic Inc, Minneapolis, MN) temporary dual-chamber pacemaker, also used for pacing if necessary. In order to determine the capture threshold, rate was set above the endogenous rate and output to its highest value. Output then was decreased until capture loss. The value of output that still allowed a sustained cardiac pacing was recorded as capture threshold. In order to determine the sensitivity threshold, rate was set below the endogenous rate and output above the capture threshold. Sensitivity initially was increased to its highest value and then decreased until the sense indicator flashed with each endogenous beat, which was recorded as sensitivity threshold. If both electrodes were placed on the epicardium, the TEW external extremities were systematically switched between the negative and positive terminals of pacing cables in order to choose the lowest threshold.

If in use, temporary pacemaker settings such as pacing mode, rate, output, sensitivity, and atrioventricular (AV) delay were recorded on the patient's flow chart. The following complications related to TEW removal were prospectively recorded: hemothorax, tamponade, retained TEW, and arrhythmia.

Statistical analysis consisted mainly of descriptive statistics. Continuous variables were presented as means ± SD or medians and nominal variables as percentages. Repeated measures analysis of variance (ANOVA) was performed for thresholds evolution. Two groups of patients were created depending on TEW pacing thresholds: TEW nonfunctional before the fourth postoperative day and TEW functional beyond the seventh postoperative day. Univariate comparisons were made between these two groups using unpaired two-tailed Student's t-test for continuous variables and chi-square or Fisher's exact test for qualitative variables. A p value of < 0.05 was considered statistically significant.

RESULTS

Two hundred thirty-six patients were enrolled in the study (out of 317 who underwent cardiac surgery during the same period) (Fig 1). The main demographic characteristics and intraoperative data are summarized in Tables 1 and 2. TEW were implanted in the right ventricle for all patients and in the right atrium for 142 (60%) patients. The mean follow-up duration was 7 ± 5 days corresponding to wire removal or insertion of a permanent device. Almost half of the TEW were removed on day 4 and 5, according to the service protocol, and 17% were still in place beyond the 10th postoperative day.

Table 1. Population Demographics

	N = 236	%	Mean ± SD	Median	Range
Age			66.5 ± 12	67	[19-90]
Males	155	66			
BMI			27.3 ± 4.7	26.9	[17.3-50.1]
ASA score			2.5 ± 0.5	2	
EuroSCORE 1			8.5 ± 10.2	5.66	[0.88-66]
EuroSCORE 2			3 ± 3.3	1.89	[0.5-26.3]
Medical History					
Atrial fibrillation/flutter	43	18			
Diabetes mellitus	62	26			
Hypertension	153	65			
Hypercholesterolemia	149	63			
Active smoking	60	25			
Dysthyroidia	27	11			
Previous cardiac surgery	5	2			
ECG					
Sinus rhythm	218	92			
Atrial fibrillation/flutter	18	8			
AV block 1	38	16			
RBBB	13	5.5			
LBBB	14	5.9			
LAHB	14	5.9			
Echocardiography					
LVEF < 40%	13	5.5			
Severe pulmonary hypertension (>55 mmHg)	11	4.6			
Left ventricular hypertrophy	121	51			

Abbreviations: AV, atrioventricular; BMI, body mass index; ECG, electrocardiography; LAHB, left anterior hemiblock; LBBB, left bundle-branch block; LVEF, left ventricular ejection fraction; RBBB, right bundle-branch block.