

The incidence of in-hospital atrial fibrillation after coronary artery bypass grafting using ventricular and atrial pacing

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Original Article

Abstract

BACKGROUND: Atrial fibrillation (AF) after coronary artery bypass graft (CABG) surgery is a common problem. In this study, we sought to evaluate the safety and tolerance of continuous atrial pacing after CABG. We hypothesized that a strategy of temporary atrial pacing after CABG would reduce the incidence of postoperative AF.

METHODS: During 2012, CABG candidates over 18 years of age at Sina Hospital (Isfahan, Iran) were recruited. Before surgery, the participants were randomly assigned to two groups of ventricular pacing and left atrial ventricular pacing (atrial pacing). The primary end point of the study was the initial occurrence of AF or atrial flutter with a ventricular rate greater than 100 beats per minute for 10 consecutive minutes or completion of the 48-hour monitoring period.

RESULTS: We evaluated 64 consecutive CABG candidates with sinus rhythm. They were allocated to two groups of ventricular pacing and atrial ventricular pacing (n = 32 in each group). Three patients in the ventricular pacing group (10%) and six in the atrial ventricular pacing group (22%) had sustained AF during the first 48 hours after CABG (P = 0.18 according to Fisher's exact test).

CONCLUSION: Continuous atrial pacing in the postoperative setting is safe and well-tolerated. In this study, we found that temporary atrial pacing increased the frequency of postoperative AF. Since the difference between the two groups was not significant, larger studies are required to determine the exact relation between pacing method and AF.

Keywords: Atrial Fibrillation, Coronary Artery Bypass Graft, Atrial Pacing

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Introduction

Atrial fibrillation (AF) after coronary artery bypass graft (CABG) surgery is a common problem.¹ It is associated with longer intensive care unit (ICU) and hospital stay and increased costs of postoperative care.² On the other hand, treatment with electrical cardioversion, antiarrhythmic and anticoagulant drugs adds significant morbidity and cost.^{1,3} Prophylactic pharmacological treatment has also been disappointing. Although a recent trial found a significant reduction in postoperative AF after treatment with amiodarone, the incidence of AF in the treatment group was still 25% and concerns about potential morbidity exist.⁴ Atrial-based pacing has become an attractive non-pharmacological therapy for the prevention of AF.⁵

Patients undergoing CABG surgery have temporary atrial and ventricular pacing wires implanted at the time of surgery. Since the incidence of AF is high among these patients, they may provide a model to examine the impact of prophylactic atrial pacing. Such a technique would also be of extreme clinical value in reducing the cost and morbidity associated with postoperative AF. In this study, we sought to evaluate the safety and tolerance of continuous atrial pacing after CABG. We hypothesized that a strategy of temporary atrial pacing after CABG would reduce the incidence of postoperative AF.

Materials and Methods

During 2012, CABG candidates over 18 years of age

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at Sina Hospital (Isfahan, Iran) were recruited. All patients had to be in sinus rhythm before surgery and on no antiarrhythmic medications. Before surgery, the participants were randomly assigned to two groups of ventricular pacing and left atrial ventricular pacing (atrial pacing). The subjects were followed for 48 hours after the operation.

Patients were excluded if they had a known history of AF or atrial flutter requiring antiarrhythmic medications, had renal or hepatic dysfunction (serum creatinine > 3mg/dl, liver enzyme tests > 3 × normalU/L), or were unable to give informed consent. In addition, patients in whom epicardial pacing wires could not be placed during surgery, or patients who developed postoperative ventricular arrhythmias requiring therapy with oral or intravenous antiarrhythmic agents other than intravenous lidocaine were excluded. Patients who required temporary pacing immediately after surgery due to hemodynamic compromise remained in the study. Baseline characteristics and history of arrhythmia were ascertained from direct patient interviews and review of their medical records.

All patients had one set of ventricular pacing wires (Model #6500, Medtronic Inc., Minneapolis, Minnesota, USA) implanted at the conclusion of surgery. Half of the patients also had atrial wires implanted in the standard location attached to the posterior surface of the left atrium between the right superior and inferior pulmonary veins. The ventricular wires were attached to the right ventricular apex in the standard fashion.

Patients in the ventricular group were paced using the single-chamber pacing mode at a backup rate of 50 pulses per minute (ppm) in the surgical ICU. Patients in the atrial group were paced with a temporary external dual-chamber pacemaker (Model #5346, Medtronic Inc., Minneapolis, Minnesota, USA) using the atrioventricular (AV) universal (DDD) mode at a lower rate limit of 100 ppm with an AV delay of 220 ms to establish continuous atrial pacing at rest. Pacemaker settings included an upper-rate limit of 140 ppm, a post ventricular atrial refractory period of 175 ms, atrial sensitivity of 0.5 mV, ventricular sensitivity of 2 mV and maximum atrial and ventricular pacing output of 20 mA. Pacing was continued for 48 hours or until the first sustained episode of AF (> 10 minutes).

After the operation, physicians were instructed to continue beta-adrenergic blocking agents in all patients who had received preoperative beta-blocker therapy. Preoperative beta-blockers were administered through the morning of surgery. Oral

metoprolol (25 mg twice daily) was also started postoperatively as soon as all intravenous inotropes were discontinued. The dose was titrated upward at the discretion of the attending surgeon. Patients not on preoperative beta-blockers received these agents in the postoperative period if no contraindications were found.

Patients were continuously monitored during the study period with a telemetry system. Pacing and sensing thresholds for both atrial and ventricular leads were checked after arrival at the ICU and daily thereafter to ensure the capture. The underlying heart rhythm and rate were documented daily. When considered stable, patients were transferred from the ICU to monitored beds in the general hospital ward where pacing was discontinued.

The primary end point of the study was the initial occurrence of AF or atrial flutter with a ventricular rate greater than 100 beats per minute for 10 consecutive minutes or completion of the 48-hour monitoring period. An investigator reviewed the hospital chart and full telemetry at least once daily to monitor the cardiac rhythm and establish the time of onset of AF.

Data analysis

All values were expressed as mean ± standard deviation (SD). Baseline characteristics of the study groups were compared using Student's t-test or analysis of variance for continuous variables and chi-square test for discrete variables. Other tests including Mann-Whitney, Fisher's exact, and Mantel-Haenszel tests were applied for analysis of data. All analyses were performed with SPSS for Windows 20.0 (SPSS Inc., Chicago, IL, USA).

Results

We evaluated 64 consecutive CABG candidates with sinus rhythm. They were assigned to two groups of ventricular pacing and atrial ventricular pacing. (n = 32 in each group). The mean age of the participants was 57.86 ± 10.16 years. Independent t-test did not show significant differences in age, LVEF, Hb level, O₂ saturation, and Cr level between the two groups (Table 1). Moreover, the two groups matched well in terms of gender distribution (P = 0.08 in chi-square test and P = 0.86 in Mantel-Haenszel test).

Chi-square test did not suggest the two groups to be significantly different in terms of risk factors such as presence of hypertension, pulmonary disease, history of smoking, and diabetes (Table 2). None of the patients in either group reported documented lung disease.

Mann-Whitney test showed that the two groups were matched in regard to angina level (according to the Canadian Cardiovascular Society classification)⁶ and level of dyspnea (according to New York Heart Association classification)⁶ (Table 3). Three patients in the ventricular pacing group (10%) and six in the atrial ventricular pacing group (22%) had sustained AF during the first 48 hours after CABG (P = 0.18 according to Fisher's exact test).

Discussion

Echocardiography recordings during the first 48 hours after CABG showed that AF occurred in 10% of patients with ventricular pacemakers and 22% of those with atrial ventricular pacemakers.

The pathogenesis of post-CABG AF has been proposed to be multifactorial with abnormal atrial conduction and lack of uniformity of atrial repolarization as main elements. It can have

different triggers including premature contractions, pericarditis, electrolyte disorders, cardiopulmonary bypass and cardioplegia.^{7,8}

The limited efficacy of conventional agents has led to searches for non-pharmacological modalities for the prevention of postoperative AF. About a decade ago, Coumel⁹ and Attuel et al.¹⁰ were among the first to report the potential of pacing in prevention of AF. They described the use of single-site atrial overdrive pacing to prevent AF or flutter in a selected group of patients with vagally mediated AF or flutter.^{9,10} Further studies by Murgatroyd et al. utilized a unique pacing algorithm for the suppression of atrial premature depolarizations.¹¹ This technique resulted in a significant reduction in episodes of AF. The mechanism by which atrial overdrive pacing reduces the occurrence of AF is unclear. However, suppression of atrial premature depolarizations and a reduction in the dispersion of refractoriness have been proposed.^{12,13}

Table 1. Description of quantitative variables

Variable	Atrial ventricular pacing			Ventricular pacing			P
	Minimum	Maximum	Mean ± SD	Minimum	Maximum	Mean ± SD	
Age	36.00	75.00	57.85 ± 9.82	28.00	78.00	57.87 ± 10.63	0.99
Creatinine	2.00	0.70	1.01 ± 0.28	3.00	0.70	1.03 ± 0.44	0.81
Oxygen saturation	95.00	99.70	98.40 ± 0.60	94.00	100.00	98.24 ± 0.96	0.48
Left ventricular ejection fraction	20.00	65.00	51.66 ± 11.00	60.00	25.00	49.80 ± 10.70	0.92
Hemoglobin	12.00	16.00	13.19 ± 2.60	9.90	15.30	13.16 ± 1.20	0.95

Table 2. Description of qualitative variables

	Atrial pacing group (%)	Atrial ventricular pacing group (%)	P
Gender	Male	88.9	0.08
	Female	11.1	
Hypertension	No	59.3	0.23
	Not known	3.7	
Smoking history	Treated	37.0	0.83
	Never	77.8	
Diabetes	Ex-smoker	11.1	0.57
	Smoker	11.1	
	No	63.0	
	On diet	3.7	
	On oral agent	33.3	
	On insulin + oral agent	0	

Values are expressed as percentages.

Table 3. Description of Angina and Dyspnea in Atrial And Ventricular Pacing groups

	Atrial ventricular pacing group (%)	Ventricular pacing group (%)	P
Angina*	1	3.7	0.44
	2	85.2	
	3	7.4	
	4	3.7	
Dyspnea**	1	7.4	0.91
	2	92.6	
	3	0	
	4	0	

* Canadian Cardiovascular Society classification

** New York Heart Association classification

Most evidence suggests that AF is a reentrant rhythm consisting of multiple wandering wavelets of electrical activity.^{14,15} It is often initiated by atrial premature beats (APB) encountering areas of slow conduction and unidirectional block.¹⁶ There are many reasons why one might expect atrial pacing to be effective in preventing AF. Increasing atrial rate suppresses the APB which may initiate AF. A prospective randomized trial found that AF recurrences are reduced in patients receiving right atrial pacing compared to those receiving ventricular pacing.¹⁷ Papageorgiou et al. found that the posterior triangle of Koch is a critical area of slow conduction and that coronary sinus (i.e. left atrial) pacing prevented the induction of AF by high right atrial APB.¹⁸

In our study, three patients in the ventricular pacing group (10%) vs. six in the atrial ventricular pacing group (22%) had sustained AF during the first 48 hours after CABG. Although the frequency of AF was higher in the atrial paced group, the difference was not significant. Another study suggested that temporary pacing may paradoxically induce AF in some patients if inappropriate sensing leads to pacing during atrial repolarization.¹⁹ While the findings of some studies about the absence of a significant reduction in recurrence of AF using atrial pacing were similar to our observations,⁵ other researchers have reported favorable effects of right atrial pacing in reducing post-CABG AF.¹⁹

Pacing was well tolerated in all patients and did not increase hospital stay. There were no complications related to the placement of left atrial pacing wires at the conclusion of surgery.

Among the strengths of our study was eliminating the effects of risk factors associated with frequency of AF. In other words, age, sex, LVEF, Cr level, pulmonary disease, diabetes mellitus, hypertension, anemia, and hypoxia were completely adjusted in the two groups.

Conclusion

Continuous atrial pacing in the postoperative setting is safe and well tolerated. In this study, we found that temporary atrial pacing increased the frequency of postoperative AF. Since the difference between the two groups was not significant, larger studies are required to determine the exact relation between pacing method and AF.

Conflict of Interests

Authors have no conflict of interests.

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