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Biatrial Pacing to Prevent Atrial Fibrillation After Coronary Artery Bypass

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ABSTRACT

Between October 1999 and December 2000, 52 patients (37 male) undergoing coronary artery bypass surgery were selected for overdrive biatrial pacing to determine its effectiveness in reducing atrial fibrillation. A pacing wire was attached to the right atrial appendage and another to the roof of the left atrium behind the aorta. The atria were paced continuously in AAI mode at a rate of 90 pulses per minute or 10 pulses above the underlying rate (maximum rate < 140/min) for 3 days. The endpoint was the onset of atrial fibrillation during hospital stay. Results were compared with those of a control group of 52 matched patients. There were no significant differences in the occurrence of atrial fibrillation (30% in the paced group vs. 25% in the control group), morbidity, or length of hospital stay. Continuous biatrial pacing after coronary bypass surgery was safe and well tolerated, however, it did not prevent or lower the incidence of atrial fibrillation.

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INTRODUCTION

Supraventricular tachyarrhythmias such as atrial fibrillation (AF) or atrial flutter have been reported to occur in 20%–50% of patients after coronary artery bypass grafting (CABG).¹⁻³ This results in significant morbidity including cerebrovascular accidents, thromboembolic complications, and hemodynamic instability, with consequent increases in length of hospital stay and overall medical costs.^{1,3} Although drugs such as beta blockers, amiodarone, and sotalol have been proven to reduce the incidence of AF after CABG, they are not without undesirable side effects that require withdrawal of treatment.⁴⁻⁹ Thus, there is keen interest in non-pharmacological strategies to prevent AF after open heart surgery. Continuous overdrive pacing was found to be effective in promoting sinus rhythm in patients with paroxysmal AF refractory to drug therapy.^{10,11} More

recently, several studies have demonstrated that overdrive atrial pacing can reduce the incidence of AF after open heart surgery.¹²⁻¹⁵ This study was undertaken to assess the effects of biatrial overdrive pacing on AF after CABG.

PATIENTS AND METHODS

From October 1999 to December 2000, 52 patients who underwent CABG were recruited for the overdrive pacing study. Exclusion criteria were emergency operation, concomitant valve or aortic surgery, presence of a permanent pacemaker or preoperative AF, preoperative antiarrhythmic therapy (with sotalol, amiodarone, propafenone, or quinidine), and post-CABG low cardiac output syndrome.

After completion of CABG and with the heart in sinus rhythm, pacing wires were attached to each atrium. One wire was attached to the right atrial appendage and the

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Table 1. Baseline Patient Characteristics

Variable	Pacing Group	Control Group
No. of patients	52	52
Mean age (years)	59.7 ± 9.8	62.3 ± 8.9
Preoperative LVEF (%)	64.7 ± 16.0	66.5 ± 14.6
Heart rate (beat·min ⁻¹)	69.8 ± 10.6	71.3 ± 13.5
Male sex (n)	37	30
Hypertension (n)	34	28
Recent myocardial infarction (n)	11	5
Diabetes mellitus (n)	27	22
Cerebrovascular accident (n)	2	5
Peripheral vascular disease (n)	3	7
Beta blockers (n)	41	38
Ca-channel blockers (n)	20	20

LVEF = left ventricular ejection fraction.

Table 2. Operative Data

Variable	Pacing Group	Control Group
Left main stenosis > 50% (n)	15	23
No. of vessels grafted	2.8 ± 0.3	2.9 ± 0.4
No. of grafts	2.9 ± 0.7	2.8 ± 0.8
Crossclamp time (min)	58.3 ± 15.6	63.1 ± 22.2
Bypass time (min)	93.2 ± 22.1	99.3 ± 26.5

Table 3. Postoperative Data

Variable	Pacing Group	Control Group
Beta blockers (n)	31	30
Ca-channel blockers (n)	16	14
Inotropics (n)	9	11
Time to onset of AF (hours)	46.7 ± 27.8	35.7 ± 11.3
Intensive care (hours)	51.2 ± 24.2	58.1 ± 32.1
Hospital stay (days)	11.2 ± 5.5	13.4 ± 8.1
Complications	9	12
Mortality	0	0

other to the roof of the left atrium just behind the superior vena cava and the aorta. The right atrial wire was assigned as the anode and the left atrial wire as the cathode. After surgery, the pacing and sensing thresholds were tested. There were 2 patients who could not be paced and were excluded from the study. The external temporary pacemaker (Medtronic dual-chamber temporary pacemaker model 5388; Medtronic, Inc., Minneapolis, MN, USA) was then programmed to AAI mode. The rate was set at 90 pulses per minute or 10 pulses above resting rate, to a maximum of 140 pulses per minute. The pacing protocol started within 4 to 6 hours after surgery when the patient was settled in the intensive care unit. Serum potassium levels were maintained between 4.5 and 5.0 mmol·L⁻¹. Continuous rhythm monitoring was performed until the day of discharge from the hospital. The pacing protocol extended for 72 hours during which, pacing thresholds were checked 4 to 6 hourly. Patients who were taking beta blockers preoperatively resumed soon after surgery when hemodynamic conditions allowed. Atrial

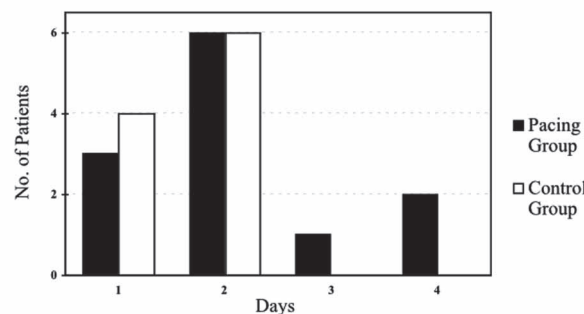


Figure 1. Incidence and onset of atrial fibrillation after coronary bypass in pacing and control groups.

fibrillation or flutter was recorded if it persisted for more than 60 minutes or if it caused hemodynamic instability requiring antiarrhythmic treatment. Once the patient developed AF, pacing was discontinued. Pacing wires were removed on the 7th postoperative day. The endpoint of the study was the occurrence of AF during hospital stay. The results of the study group were compared with those of a control group of 52 patients who underwent isolated CABG surgery and who were matched for demographic characteristics and preoperative risk factors.

Results are presented as mean ± standard deviation. Continuous variables were analyzed with Student's *t* test using SPSS version 10.0 software (SPSS, Inc., Chicago, IL, USA). The chi-squared test was used for analysis of noncontinuous variables. A *p* value less than 0.05 was considered statistically significant.

RESULTS

Fifty-two patients (37 males) were enrolled in the pacing study. Their mean age was 59.7 ± 9.8 years (range, 38 to 78 years). Beta blockers and calcium-channel blockers were prescribed to 41 and 20 patients, respectively, in the pacing group. Baseline characteristics of both groups are compared in Table 1; there were no statistically significant differences in any of the parameters. Operative data of both groups are shown in Table 2; again, there were no statistically significant differences between the two groups.

The incidence of AF was 30% (12 patients) in the pacing group and 25% (10 patients) in the control group (*p* = 0.81). The mean time to onset of post-CABG AF was not significantly different between groups (Figure 1). Patients who developed AF were managed with intravenous amiodarone, with a success rate of 100% in the pacing group. In the control group, 2 patients remained in AF despite treatment with amiodarone, and were converted to sinus rhythm by electrical cardioversion. All patients were discharged from the hospital in sinus rhythm. The numbers of patients prescribed beta blockers or calcium-channel blockers postoperatively were no different between the pacing and control groups (Table 3).

The incidence of AF among patients given beta blockers postoperatively in the pacing and control groups were 12.9% and 20%, respectively ($p = 0.51$). The mean intensive care unit stay and the mean hospital stay were not significantly different in the two patient groups. There were no serious complications related to insertion or removal of the pacing wires. The postoperative complication rates of the pacing group and the controls were 17.3% and 23.1%, respectively, and there was no mortality in either group (Table 3).

DISCUSSION

The incidence of AF of the control group was consistent with other series.^{1-3,12-15} The failure of atrial overdrive pacing to prevent AF after CABG has been reported previously.¹⁶⁻¹⁸ One of the possible reasons was failure of the temporary pacemaker to sense the atrial electrical activity, in particular, a pacemaker model that has a high minimal sensing threshold could lead to asynchronous pacing of the atrium and trigger AF.¹⁶ It was this proarrhythmic effect of overdrive atrial pacing which forced Kurz and colleagues¹⁷ to terminate their study prematurely. However, this phenomenon was not detected in our study. The pacemaker used in this study had a minimal sensing threshold of 0.4 mV that could detect most of the atrial depolarization and thus avoid asynchronous atrial pacing.

Atrial overdrive pacing has been shown to convert AF to sinus rhythm, with a good success rate; the theory and details of the procedure have been well described.^{19,20} Liebold and colleagues²¹ were the first to demonstrate a 100% conversion rate of AF by low energy defibrillation via epicardial biatrial wires. However, only patients with induced AF rather than post-CABG AF were included, so the efficacy in post-CABG patients needed further study. In this series, both groups of patients had similar characteristics in terms of age, gender, left ventricular function, and beta-blocker usage, therefore, failure to reduce the incidence of AF in this study was not due to sampling bias.³ The combination of beta blockers and atrial overdrive pacing had been shown to lower the incidence of AF after CABG, but the usefulness of this combination was not demonstrated in this study.¹³ On the other hand, the combination of amiodarone or other antiarrhythmic agents with overdrive atrial pacing were not studied previously, and their effectiveness remains to be determined.

In the majority of cases, the onset of post-CABG AF was within 72 hours postoperatively, which is consistent with other reports.¹⁻³ Therefore, the duration of atrial pacing in our study protocol would have adequately covered the potential onset of post-CABG AF. Placement of the pacing wire at the left atrial roof was well tolerated. We did not encounter the side effect of phrenic nerve stimulation

which was reported when the wire was placed near the interatrial groove and the right pulmonary veins.¹⁶ There has also been controversy about the efficacy of uniatrial versus biatrial pacing in preventing post-CABG AF; Daubert and colleagues²² reported better control of post-CABG AF with uniatrial overdrive pacing. It was concluded from this case-controlled study that although continuous biatrial pacing in the post-CABG setting was safe and well tolerated, it failed to prevent post-CABG AF. The role of combined overdrive atrial pacing and antiarrhythmic medications for reducing AF after CABG surgery warrants further study.

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