PLACING EPICARDIAL PACING WIRES IN ISOLATED CORONARY ARTERY BYPASS GRAFT SURGERY–A PROCEDURE ROUTINELY DONE BUT RARELY BENEFICIAL

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Background: After Coronary Artery Bypass Graft (CABG) surgery, temporary epicardial pacing wires are placed on heart to meet unforeseen complications like bradyarrhythmias or asystoles. This step needs additional time, resources and has potential to cause complication. Even having less complications, is this additional step in elective CABG surgery necessary? Some important predictive factors in patients who require this pacing wire placement have to be isolated. The objective of the study was to avoid this step if not required especially in elective CABG surgery. **Methods:** This prospective observational study involved 1047 consecutive patients undergoing CABG at our institution from May 2006 to April 2008. Patient who did not receive pacing wire (230), Preoperative pacemaker (2), CABG with valvular surgery (10), CABG with Ischemic VSD or MR surgery (3), off-pump CABG (21), or incomplete follow-up (11) were excluded from the study. Patients who received pacing wire (770) were divided in two groups. Group A, consisted of patients who did not require pacing postoperatively 748 (97.1%), and Group B, who required pacing postoperatively 22 (2.9%). Both groups were compared in demographic, preoperative, per-operative and postoperative variables. The incidence of pacing during the postoperative period was recorded. Predictors for postoperative pacing were determined using medical records and the AFIC/NIHD cardiac surgery database. **Results:** In the postoperative period, 22 of 770 patients (2.9%) required pacing. Analysis identified age (p=0.02), preoperative arrhythmia, especially Bundle Branch Block (p=0.000), pacing utilized at separation from bypass (p=0.000) and use of antiarrhythmics on leaving the operating room (p=0.015) as predictors of the need for postoperative pacing. Diabetes, considered one of the major factor requiring pacing was not significant in our study (p=0.379). Preoperative arrhythmias, pacing utilized to separate from bypass and use of antiarrhythmics on leaving the operating room were found to be three most significant risk factors. If the patients with any of these three risk factors are excluded, only 1.11% (8/716) of them would have required pacing. **Conclusions:** Procedure of routine use of temporary epicardial pacing after elective CABG surgery has negligible role, rather has additional cost and potential of rare complications. Diabetes is not a risk factor for post operative pacing.

Keywords: Coronary artery bypass graft (CABG) surgery, arrhythmia, cardiac pacing

INTRODUCTION

Most of the patients undergoing cardiac surgery receive temporary epicardial pacing wires (TEPW).[1,2] TEPWs are routinely placed on the epicardium the outer layer of heart muscle—during surgery. The wires extending from the leads provide quick access to a temporary pacemaker's pulse generator in case something goes wrong in the early postoperative period. The surgeon loosely sutures the leads onto the epicardium and threads the wires through to the outside of the chest via small, stab-like incisions. The wires are attached, either at the atrium or ventricle[3] (Figure-1) or both, may be paced as needed by the pulse generator. These pacing wires remain in place anywhere from 24 hours to several days postoperatively (Figure-2).

These wires, connected with pacemaker are utilized to maintain the rhythm of heart which is necessary for optimum haemodynamics[4]. They are mostly used for bradyarrhythmias or asystole but they can also be used less frequently to suppress both atrial and ventricular tachyarrhythmias.[5]

The role of TEPW is proven in patients undergoing open heart surgery for valvular or congenital heart diseases.[6] Because these patients have rhythm problem due to direct effects to conductive tissue of heart during surgery. But the role of these wires is controversial in CABG[7–9], especially when the procedure is not associated with any complication or risk factors.

Very few studies have been conducted on this controversial issue. Some studies identified risk factors for patients who might need pacing postoperatively, and diabetes was identified as one of the three major risk factors.[7,10] Infrequent but serious complications have been described in association with TEPW use.[11] Rarely, catastrophic complications have also been reported.[12]

While TEPW are meant to provide a safeguard against dysrhythmias, they have the potential to cause a lethal rhythm.[13] Because the unattached wires provide a direct route for electrical current to flow to the heart, any stray current poses a threat to the patient. Microshocks can pass right through the attending staff and into the patient. As little as 0.1 mA can cause ventricular fibrillation.[14]

The complications can occur during insertion like bleeding, accidental removal, dislodgement and fracture of pacing wires. They can occur during functioning like failed sensing or capture, phrenic nerve irritation, diaphragmatic stimulation causing pain[15] and hiccups. More dangerous complications occur on removal like retained wire[16], haemorrhage and tamponade associated with injuries to saphenous vein grafts[12] and atrial and ventricular lacerations. Rhythm problems like premature ventricular contractions[17] and non sustained ventricular tachycardia are also noted on removal.[18] There are remote chances of infection as well.[19] Finally, patients may experience a delay in discharge awaiting wire removal, especially in the anticoagulated patient.

Given these rare but significant complications, the aim of this study was to provide data identifying patient characteristics that could predict the need for pacing after routine coronary artery bypass grafting (CABG) with the potential to reduce its indiscriminate use.

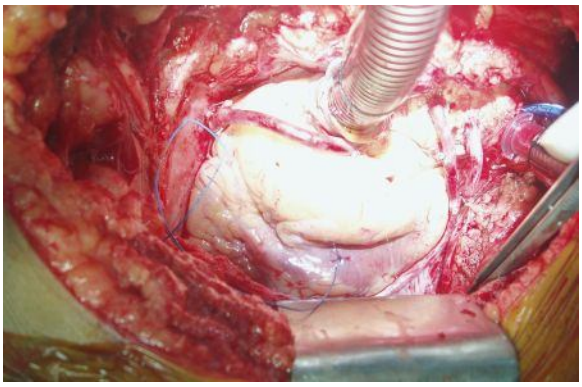

Figure-1: TEPW placed on right ventricle during surgery

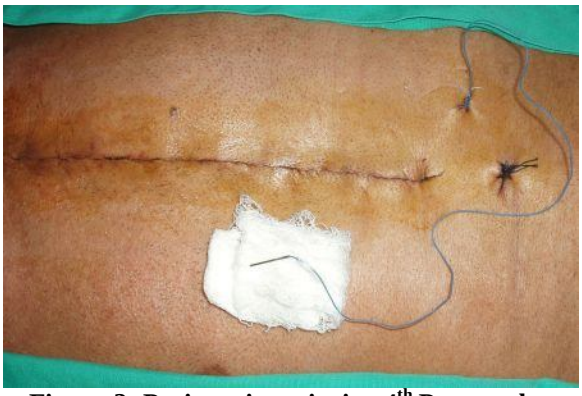

Figure-2: Pacing wire exit site–4th Post-op day

PATIENTS AND METHODS

All patients undergoing isolated CABG surgery during 2 year period from May 2006 to April 2008 were included in the data set. AFIC/NIHD Institutional Review Board approved the data collection.

All patients were observed prospectively during their hospital stay. Patients having CABG were identified. A total of 1047 consecutive patients underwent elective coronary artery bypass during the 2 years period of this study. Two hundred and seventy-seven patients were excluded because 230 did not receive pacing wire, 2 preoperative pacemaker, 10 CABG with valvular surgery, 3 CABG with Ischemic VSD or MR surgery, 21 had off-pump coronary artery bypass grafting and 11 patients had incomplete data. AFIC/NIHD cardiac surgery database and medical records were used to compile the data. Postoperative complications were monitored for all patients while hospitalized.

A preoperative arrhythmia was defined as a bundle branch heart block, atrioventricular heart block, or atrial fibrillation. Preoperative sinus bradycardia was not considered to be a preoperative arrhythmia because many patients (>20%) were taking beta blockers preoperatively. A preoperative 12-lead electrocardiogram was used to identify conduction problems. Preoperative myocardial infarction (MI) was defined as a history of MI and an acute or evolving MI. Patients requiring temporary pacing in the postoperative period were included if either atrial, ventricular, or bichamber pacing was used leaving the operating room or in the immediate postoperative period.

All patients underwent median sternotomy. Cardiopulmonary bypass was carried out. Moderate systemic hypothermia (32 °C) and topical cardiac hypothermia was used to reduce temperature. Mostly antegrade blood cardioplegia and in few (~5%) both antegrade and retrograde cardioplegia were used.

Most patients receive only ventricular wires that are placed on the anterior or diaphragmatic surfaces of the right ventricle. Atrial wires were additionally placed when AV block occurred after separation from cardiopulmonary bypass.

Postoperatively, patients were evaluated on an individual basis to determine if pacing is required. This may include significant bradycardia and associated haemodynamic instability. Additionally, inotropes were used only if required.

The analyses were made using the SPSS-15 statistical software. Dichotomous variables were expressed as percentages, and continuous variables were expressed as the mean. For analysis, χ^2 was used for dichotomous variables and the Student *t*-test (for non-normally distributed data) was used for continuous variables. Variables with *p*-values equal to or less than 0.05 were considered significant.

RESULTS

The data of 770 patients who had pacing wires was analysed and is tabulated in Table-1. The mean age of the patients was 55.75±9.0 years and mean cardiopulmonary bypass time was 96.7±32 minutes. Mean cross clamp time was 53.91±18.4. The patients were followed up for an average of 78.87 hrs length of ICU stay, the most vulnerable time of developing arrhythmias.

Table-1: Comparison of non-paced and paced groups

Variable	Group A (n=748)	Group B (n=22)	*p* value
Preoperative factors			
Age	55.75±9.0	60.27±7.2	0.019
Gender (female)	78 (10.42%)	1(4.54%)	0.714
Diabetes mellitus	208 (27.8%)	8 (36.36%)	0.379
Hypercholesterolemia	370 (49.46%)	10 (45.45%)	0.711
Hypertension	259 (34.62%)	12 (54.54%)	0.054
History of CVA	5 (0.66%)	1(4.54%)	0.160
Weight (kg)	73.23±11.33	70.55±11.04	0.274
Body mass index	26.23±4.64	25.49±3.47	0.455
Pre operative Beta blockers	153 (20.45%)	5 (22.72%)	0.796
Angina duration			
Angina asymptomatic	58 (7.75%)	2 (9.09%)	0.81
Angina <6months	438 (58.5%)	13 (59.09%)	
Angina >6months	252 (33.68%)	7 (31.8%)	
CCS class			
CCS Class I-II, asymptomatic	543 (72.59%)	18 (81.81%)	0.338
CCS Class III-IV	205 (27.4%)	4 (18.18%)	
NYHA class			
NYHA Class I-II, asymptomatic	681 (91.04%)	22 (100%)	0.247
NYHA Class III-IV	67 (8.95%)	0 (0%)	
History of arrhythmias	8 (1.06%)	6 (27.27%)	0.000
Atrial fibrillation	1 (0.13%)	1(4.54%)	0.058
AV block	1 (0.13%)	1(4.54%)	0.058
BBB	6 (0.80%)	4 (18.18%)	0.000
Previous Q wave infarcts	125 (16.7%)	3 (13.63%)	1.00
Left main stem disease	107 (14.3%)	6 (27.27%)	0.156
Ejection Fraction	53.45±7.7	55.23±6.8	0.288
Emergency surgery	11 (1.47%)	1(4.54%)	0.302
Operative room factors			
Endarterectomy	52 (6.95%)	2 (9.09)	0.663
Mean cross clamp time	53.91±18.4	51.27±17.4	0.507
Mean Bypass time	96.7±32	102.5±45	0.411
Inotropic support in coming off			
No Inotropic support	229 (30.6%)	4 (18.18%)	0.21
Inotropic support (mild)	414 (55.34%)	14 (63.63%)	
Inotropic support (moderate to heavy)	105 (14.03%)	4 (18.18%)	
Cardiovertion required	51 (6.81%)	4 (18.18%)	0.08
Antiarrhythmics on leaving OR	27 (3.6%)	4 (18.18%)	0.015
Pacing requirement on coming off	6 (0.80%)	13 (59.09%)	0.000
Use of Intra Aortic Balloon Pump (IABP)			
Before surgery	39 (5.21%)	2 (9.09%)	0.42
During & After surgery	37 (4.94%)	5 (22.72%)	
Post operative factors			
Renal complication	7 (0.93%)	3 (13.63%)	0.003
Reopening	27 (3.6%)	3 (13.63%)	0.060
Ventilation time (Hrs)	19.99±55.9	71.0±93.1	0.000
ICU stay (Hrs)	77.5±86.6	122.9±15.4	0.081
Inotropes required (Hrs)	55.6±87.1	112.7±118.6	0.036
Max CKMB in 1st 24 hrs	81.45±96.6	99.77±86.3	0.38
Mortality	24 (3.2%)	4 (18.18%)	0.010

In the immediate postoperative period, 22 of 770 patients (2.6%) required pacing. The indications for pacing included postoperative sinus bradycardia in 14, atrioventicular block in 2, bundle branch block in 4 and cardiac arrest in 2. Of the 22 patients who were paced in the postoperative setting, only 1 required a permanent pacemaker. This patient had persistent complete heart block.

In preoperative factors, older age, hypertension and arrhythmias especially BBB were found significant. Diabetes mellitus was found to have no significance (p=0.379). In operating room events, pacing on coming off and use of anti arrhythmics were significant factors. Postoperatively, group B had significantly more complications in terms of prolonged ventilation time, prolonged inotropes requirement, renal complications and death. There were 4 (18.18%) deaths in the early postoperative period in the paced group. There were 24 (3.2%) deaths in the 748 non-paced patients.

Out of all above, three most significant factors turned out to be bundle branch block (BBB) (p=0.000), pacing on coming off (p=0.000), and use of antiarrhythmics on leaving the operating room (p=0.015). If the patients with any of these three risk factors are excluded, only 1.11% (8/716) of them would have required pacing.

DISCUSSION

Every cardiac surgical centre has its protocol of placing temporary epicardial pacing wires in isolated CABG patients. Most centres using primarily ventricular[20,21] wires whereas others use both atrial and ventricular wires[22]. In our study we used ventricular wires in (97.8%) and atrial and ventricular in (2.2%), mostly in those having AV blocks. Most temporary pacing wires are considered to be associated with a low morbidity, however, there have been reported rare catastrophic complications. Because the deadly complications are rare[12], little research has been done to predict which patient populations are most likely to require the use of temporary pacing in the postoperative setting.[7]

The mean age of the patients (55.75 years) was about 9 years less as compared to international literature.[7] A number of patients had significant co-morbidities including diabetes mellitus (28%) and hypertension (35%). In our patients 16.6% had a history of a preoperative myocardial infarction and 27.1% were having angina CCS class III or IV.

All patients underwent standard isolated coronary artery bypass grafting utilizing cardiopulmonary bypass. Some centres use mild inotropic support as a protocol[7] in every patient. We used inotropic support only when it was required.

Temporary wires have been used in the perioperative period to improve patient haemodynamics[23] as well as to suppress malignant arrhythmias[8]. Of the 22 patients who were paced, only 1 required a permanent pacemaker. Pacing was done because of postoperative sinus bradycardia in 14, atrioventicular block in 2, bundle branch block in

4 and cardiac arrest in 2. Two patient had persistent complete heart block The remaining 17 patients received temporary pacing for bradycardia, or to optimize their haemodynamic function while in the intensive care unit.

In the postoperative period, 22 of 770 patients (2.9%) required pacing which is significantly less as compared to international figure, 10 (8.6%). It may be because we operated upon relatively younger patients, having less frequency of preoperative arrhythmias and better CCS and NYHA class. Analysis identified age (p=0.02), preoperative arrhythmia (especially Bundle Branch Block p=0.000), pacing utilized at separation from bypass (p=0.000) and use of antiarrhythmics on leaving the operating room (p=0.015) as predictors of the need for postoperative pacing. Diabetes mellitus which has been quoted extremely significant in international literature was not found a significant factor (p=0.379).[7]

Although the patients in group B (paced) had significantly more post-operative complications like renal failure, reopening and resultantly required significantly more inotropic supports and prolonged ICU stay but these are postoperative outcomes, hence does not influence the decision of placement of pacing wire.

Although there were significantly more deaths in paced group compared to non-paced group, there was not any major morbidities or mortalities related to temporary pacing wires in this patient population. No deaths were related to pacing wires.

This study was limited by the small sample size in group B and by the inherent design of observational studies, such that, patients were not randomized to receive pacing wires. However, our study included about three times bigger patient population (1047) than that of international study (290).[7]

This study does identify specific patient characteristics associated with postoperative utilization of pacing wires. Based on this, fewer pacing wires are being placed in our institute. Currently, only 73% of isolated CABG patients at our institution receive pacing wires although some centres are using even lesser pacing wires.[7] In a very recent study of 2008 its limited role even in congenital heart surgery is proved.[24] On the other hand, progress is being made in development of safer pacing wires.[25]

CONCLUSIONS

Only about 1% of patients require temporary epicardial pacing after standard isolated CABG, if three most important predictors associated with postoperative pacing requirements are addressed before hand. Diabetes is not a significant risk factor for pacing requirement. By selectively using temporary epicardial pacing wires, patient morbidity can be minimized, and at the same time can decrease postoperative length of stay, thus improving cost effectiveness.

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REFERENCES

1. Elmi F, Tullo NG, Khalighi K. Natural history and predictors of temporary epicardial pacemaker wire function in patients after open heart surgery. Cardiology 2002;98:175–80.
2. Sorensen ER, Manna D, McCourt K. Use of epicardial pacing wires after coronary artery bypass surgery. Heart Lung 1994;23:487–92.
3. Curtis JJ, Maloney JD, Barnhorst DA, Pluth JR, Hartzler GO, Wallace RB. A critical look at temporary ventricular pacing following cardiac surgery. Surgery 1977;82:888–93.
4. Hartzler GO, Maloney JD, Curtis JJ, Barnhorst DA. Hemodynamic benefits of atrioventricular sequential pacing after cardiac surgery. Am J Cardiol 1977;40:232–6.
5. Archbold RA, Schilling RJ. Atrial pacing for the prevention of atrial fibrillation after coronary artery bypass graft surgery: a review of the literature. Heart 2004;90:129–33.
6. Victoria Jowett, Nicholas Hayes, Shankar Sridharan, Philip Rees, Duncan Macrae Timing of removal of pacing wires following paediatric cardiac surgery. Cardiol Young. 2007;17:1–5.
7. Bethea BT, Salazar JD, Grega MA, Doty JR, Fitton TP, Alejo DE, *et al*. Determining the utility of temporary pacing wires after coronary artery bypass surgery. Ann Thorac Surg 2005;79:104–7.
8. Puskas JD, Sharoni E, Williams WH, Petersen R, Duke P, Guyton RA. Is routine use of temporary epicardial pacing wires necessary after either OPCAB or conventional CABG/CPB? Heart Surg Forum 2003;6:E103–6.
9. Samuels LE, Samuels FL, Kaufman MS, Morris RJ, Brockman SK. Temporary epicardial atrial pacing electrodes: duration of effectiveness based on position. Am J Med Sci 1998;315:248–50.
10. Imren Y, Benson AA, Oktar GL, Chema FH, Comas G, Naseem T. Is use of temporary pacing wire following coronary artery bypass surgery really necessary? J Cardiovasc Surg (Torino). 2008;49:261–7.
11. Del Nido P, Goldman BS. Temporary epicardial pacing after open heart surgery: complications and prevention. J Card Surg 1989;4:99–103.
12. Price C, Keenan DJ. Injury to a saphenous vein graft during removal of a temporary epicardial pacing wire electrode. Br Heart J 1989;61:546–7.
13. Jackson M, Woods SS. Temporary transvenous and epicardial pacing. In Lynn-McHale Wiegand DJ, Carlson KK. (Eds). AACN procedure manual for critical care. St. Louis: Elsevier Saunders. 2005: p 349–61.
14. Shamloo, C. Epicardial pacing wire removal. In Lynn-McHale Wiegand DJ, Carlson KK. (Eds). AACN procedure manual for critical care. St. Louis: Elsevier Saunders; 2005. p 311–3.
15. Roschkov S, Jensen L. Coronary artery bypass graft patients' pain perception during epicardial pacing wire removal. Can J Cardiovasc Nurs 2004;14:32–8.
16. Gentry WH, Hassan AA. Complications of retained epicardial pacing wires: an unusual bronchial foreign body. Ann Thorac Surg 1993;56:1391–3.

17. Carroll KC, Reeves LM, Andersen G, Ray FM, Clopton PL, Shively M. Risks associated with removal of ventricular epicardial pacing wires after cardiac surgery. Am J Crit Care 1998;7:444–9.
18. Meier DJ, Tamirisa KP, Eitzman DT. Ventricular tachycardia associated with transmyocardial migration of an epicardial pacing wire. [Case Reports, Journal Article] Ann Thorac Surg 2004;77:1077–9.
19. [Domaradzki W, Olszówka P, Mrozek R, Kargul T, Zurek P, Wos s. Mediastinal abscess as a remote complication of CABG combined with temporary cardiac pacing–a case report**.** Kardiol Pol 2005;63:70–2.]
20. Hodam RP, Starr A. Temporary postoperative epicardial pacing electrodes. Their value and management after open-heart surgery. Ann Thorac Surg 1969;8:506–10.
21. Waldo AL, MacLean WA, Cooper TB, Kouchoukos NT, Karp RB. Use of temporarily placed epicardial atrial wire electrodes for the diagnosis and treatment of cardiac arrhythmias following open-heart surgery. J Thorac Cardiovasc Surg 1978;76:500–5.
22. Fernández AL, García-Bengochea JB, Sánchez D, Alvarez J. Temporary left ventricular pacing after cardiac surgery. Eur J Cardiothorac Surg 2006;29:633–4.
23. Jong, MD, Coombs V. Patient management: Cardiovascular system. In: Morton PG, Fontaine DK. (Eds.), Critical care nursing, A holistic approach. Philadelphia: Lippincott Williams & Wilkins, 2005; p.350–9.
24. Fishberger SB, Rossi AF, Bolivar JM, Lopez L, Hannan RL, Burke RP. Congenital cardiac surgery without routine placement of wires for temporary pacing. Cardiol Young 2008;18:96–9.
25. Narita Y, Fukuhira Y, Kagami H, Kitazono E, Kaneko H, Sumi Y, *et al.* Development of a novel temporary epicardial pacing wire with biodegradable film. Ann Thorac Surg 2006;82:1489–93.

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