Scientific Research Publishing

Open Journal of Thoracic Surgery, 2022, 12, 21-32
https://www.scirp.org/journal/ojts
ISSN Online: 2164-3067
ISSN Print: 2164-3059

The Need for Cardiac Pacing after Isolated Coronary Artery Bypass Graft Surgery

Montaser Elsawy Abd Elaziz[1,2], Eman Gomaa Saleh[2,3], Mohamed Gaber Elsayed[2], Bassem A. Hafez[1]

[1]Cardiothoracic Surgery Department, Faculty of Medicine, Menoufia University, Menoufia, Egypt
[2]Faculty of Medicine, Jazan University, Jazan, Saudi Arabia
[3]Neuropsychiatry Department, Faculty of Medicine, Menoufia University, Menoufia, Egypt
Email: montaserabdelaziz5@gmail.com, emansaleh364@gmail.com, gaboooor@hotmail.com, dr_bassemali@yahoo.com

How to cite this paper: Elaziz, M.E.A., Saleh, E.G., Elsayed, M.G. and Hafez, B.A. (2022) The Need for Cardiac Pacing after Isolated Coronary Artery Bypass Graft Surgery. *Open Journal of Thoracic Surgery*, **12**, 21-32.
https://doi.org/10.4236/ojts.2022.122003

Received: April 8, 2022
Accepted: May 15, 2022
Published: May 18, 2022

Abstract

Background: The aim of this study is to assess the necessity of temporary cardiac pacing and identify the predictors of pacing after coronary artery bypass graft (CABG). **Methods:** This was a retrospective observational study of 150 patients who had isolated CABG between November 2013 and December 2021. Patients were classified into two groups: group A, (n = 135) who did not need to be paced and group B, (n = 15) who needed temporary epicardial pacing. Only 10% (15/150) of patients in the study needed pacing. The primary outcome variable was assessment of the need for postoperative temporary cardiac pacing (TCP) (patients were paced during chest closure or at any time during hospital admission). The incidence of pacing during the postoperative period was observed. Univariate and multivariate predictors for postoperative pacing were determined and specicific predictors for cardiac pacing were found. **Results:** In both univariate and multivariate analysis, Old age > 65 years, diabetes mellitus, pacing to come off cardiopulmonary bypass (CPB), CPB time > 100 min, cardioversion to leave OR, antiarrhythmics to leave OR and new onset of atrial fibrillation (AF), were found to be significant predictors for the need to cardiac pacing. **Conclusion:** After coronary artery bypass surgery, a small percentage of patients require TCP. We emphasize unique predictors for postoperative pacing in this study.

Keywords

Temporary, Epicardial Pacing, Coronary Artery Bypass, Arrhythmias

1. Introduction

Temporary epicardial pacing wires are utilized during the perioperative phase to

diagnose arrhythmias and treat a range of heart rhythm disorders. Some centers have advocated for discontinuing the routine installation of temporary pacing wires [1].

The argument for this shift in practice is that temporary pacing wires are linked to dangerous postoperative complications, and the incidence of postoperative arrhythmias and heart block is now low due to advancements in myocardial protection and surgical techniques. There is little data about the complications associated with the use of pacing wires, with only isolated case reports describing events such as cardiac perforation, tamponade, foreign body retention, wire migration, and wire-induced arrhythmias [2] [3].

Other centers, on the other hand, have demonstrated the routine use of temporary pacing wires with no major complications [4] [5] [6]. Since 1960, epicardial pacing wires have been routinely employed in cardiac surgery. Complete AV block is one of the most common reasons for placing ventricular epicardial pacing wires [7].

Complete AV block is common after CABG after the release of the aortic cross-clamp and causes haemodynamic compromise, necessitating ventricular epicardial pacing wires to maintain haemodynamic stability [8].

Given these uncommon but significant complications, the goal of this study was to collect data identifying patient characteristics that could predict the need for pacing after routine CABG, potentially limiting its use.

2. Materials and Methods

2.1. Study Design

Between November 2013 and December 2021, a retrospective study was conducted on 150 patients who underwent isolated coronary artery bypass graft surgery at Menoufia University Hospitals, Cardiothoracic Surgery Department, Egypt and Prince Faisal Ben Khaled Cardiac Center, Aseer, KSA. We analyzed databases of patients from the Cardiothoracic Surgery Department and the Cardiac Intensive Care Unit after the study protocol was approved by the Ethics Committee of our institutions. Patients excluded from the study those who had off-pump coronary artery bypass grafting, patients didn't have pacemaker wires inserted, patients had incomplete data, also redo cases and patients with preoperative high degree atrioventricular block (AVB). A preoperative arrhythmia was defined as a bundle branch block, atrioventricular block, or atrial fibrillation. Preoperative sinus bradycardia was not considered to be a preoperative arrhythmia because many patients (16.7%) were taking beta blockers preoperatively. Conduction problems were discovered using a preoperative 12-lead ECG. Myocardial infarction (MI) was defined by a historyof MI, and an acute or developing MI that was studied independently. According to the need for epicardial pacing either intraoperative at the time of chest closure or in the postoperative period at any time before hospital discharge, Patients were classified into two groups: group A; (n = 135) who did not need to be paced and group B; (n = 15)

who needed temporary epicardial pacing. Only 10% (15/150) of patients in the study needed pacing. All patients required temporary pacing in the postoperative period were included if either atrial, ventricular, or bichamber pacing was used. The majority of patients simply have ventricular wires implanted on the anterior or diaphragmatic surfaces of the right ventricle. Atrial wires were additionally placed when AV block occurred after separation from cardiopulmonary bypass. Patients were assessed individually after surgery to see if pacing was necessary. Significant bradycardia and concomitant haemodynamic instability may be seen. Additionally, inotropes were used only if required.

The primary outcome variable was the need for postoperative TCP (if patients were paced at the time of chest closure or at any time before hospital discharge). We analyzed the demographic, clinical, preoperative (including drugs directly affecting the conduction system), and intraoperative variables as potential predictors of TCP.

2.2. Operative Technique

Median sternotomy was performed in all cases. Cardiopulmonary bypass (CPB) was established between the ascending aorta and venous cannulation. The perfusion rate was regulated between 2.0 and 2.4 L/min/m^2, and the systemic perfusion pressure was kept between 60 and 80 mmHg. Myocardial protection was achieved with antegrade intermittent cold blood cardioplegia at rate of 200 - 250 ml/min. Cold saline was used to cool surface of the heart. The patients were kept at a temperature between 28 and 320 C. To decide if TCP was required, each patient was assessed individually.

Ventricular wires were implanted on the anterior surface of the right ventricle. When AVB occurred after separation from CPB, atrial wires were also implanted. All of the patients were moved to the cardiac ICU after surgery and were placed on mechanical ventilation. In all of the patients, continuous ECG monitoring was used. All patients had a 12-lead ECG done upon ICU admission and on a daily basis until they were discharged from the hospital. Conduction disturbances were diagnosed using a 12-lead ECG. AVB of any degree, poor cardiac output, sinus bradycardia, and asystole were the most common reasons for pacing.

2.3. Statistical Analysis

SPSS statistical software version 19 was used to conduct the univariate and multivariate regression analyses. Continuous variables were expressed as the mean, whereas dichotomous variables were expressed as percentages. The factors that were significant at the univariate level were then entered into the multiple regression analysis. The independent impacts of potential predictors on the dependent variable were examined using stepwise forwards multiple logistic analyses. Multivariate logistic regression analysis was used to incorporate univariate characteristics with a p 0.05 value. Variables having p values of less than

or equal to 0.05 were deemed significant.

3. Results

Table 1 showed the characteristics of both groups with p-values. We noticed a statistically significant difference between patients needed TCP and those who did not need regarding the age, sex, NYHA class, while preoperative ejection fraction, and pulmonary artery pressure didn't show significant difference. Of patients below 65 years, only 2.2% needed pacing. Also all patients (15) who needed pacing was male and no female patient needed it. 30% of patients had NYHA class I-II, while 70% had NYHA class IV-V with statistically significant difference between patients, (p value = 0.007). All NYHA class III-IV patients needed pacing. Only 16.7% of patients were on B-blockers, 20% of patients on B-blockers needed pacing. 5.3% of patients were on amiodarone preoperatively with significant difference between those who were under amiodarone and those who not. Of patients on amiodarone, 87.5% needed pacing. In patients with PAP more than 45 mmHG, only 22% needed pacing. Patients who had EF less than 40%, only 3.5% needed epicardial pacing.

Table 1. Univariate Analysis for use of temporary pacing according to basic characteristics.

Variables n (%)	Total n = 150	Group A (n = 135)	Group B (n = 15)	P-value
Age				
<65 years	90 (60)	88 (97.8)	2 (2.2)	0.0001
>65 years	60 (40)	47 (78.3)	13 (22.7)	
Sex				
Male	110 (73.3)	95 (86.4)	15 (13.6)	0.01
Female	40 (26.7)	40 (100)	0 (0)	
NYHA class				
I-II	45 (30)	45 (100)	0 (0)	0.007
III-IV	105 (70)	90 (85.7)	15 (14.3)	
Beta Blockers				
No	125 (83.3)	115 (92)	10 (8)	0.06
Yes	25 (16.7)	20 (80)	5 (20)	
Amiodarone				
No	142 (94.7)	134 (94.4)	8 (5.6)	0.000
Yes	8 (5.3)	1 (12.5)	7 (87.5)	
PAP				
<45 mmHg	100 (66.7)	96 (96)	4 (4)	0.66
>45 mmHg	50 (33.3)	39 (78)	11 (22)	
Preoperative EF				
>40%	98 (65.3)	90 (91.8)	8 (8.2)	0.3
<40%	52 (34.7)	45 (86.5)	7 (3.5)	

NYHA class: New York Heart Association, PAP: Pulmonary Artery Pressure, EF: Ejection fraction, P value < 0.05 is significant.

Table 2 displayed the univariate analysis of clinical and preoperative characteristics of patients in both groups in relation to TCP. Diabetes mellitus, a history of arrhythmias, a history of COPD, a history of PTCA, and the presence of left main disease all differed significantly in terms of TCP use. Patients who have DM, 32.5% of them were paced postoperatively, only 23.3% of patients with history of arrhythmias needed pacing, 33.4% of patients who have history of stroke required pacing, only 12.5% of hypertensive patients were paced postoperatively, 20% of COPD patients were paced, only 8% of angina patients were reported to be paced, and 18% of patients with LM stenosis > 50% were paced.

Table 2. Univariate analysis for use of temporary pacing according to medical history.

Variables	Total n = 150	Group A (n = 135)	Group B (n = 15)	P-value
D.M				
No	110 (73.3)	108 (98.2)	2 (1.8)	By FE P < 0.0001*
Yes	40 (26.7)	27 (67.5)	13 (32.5)	
History of arrhythmias				
No	90 (60)	89 (98.9)	1 (1.1)	0.00*
Yes	60 (40)	46 (76.7)	14 (23.3)	
History of stroke				
No	147 (98)	133 (90.5)	14 (9.5)	0.17
Yes	3 (2)	2 (66.6)	1 (33.4)	
History of Hypertension				
No	70 (46.7)	65 (92.9)	5 (7.1)	0.3
Yes	80 (53.3)	70 (87.5)	10 (12.5)	
History of COPD				
No	110 (73.3)	103 (93.6)	7 (6.4)	0.01
Yes	40 (26.7)	32 (80)	8 (20)	
History of Angina				
No	50 (33.3)	43 (86)	7 (14)	0.25
Yes	100 (66.7)	92 (92)	8 (8)	
History of PTCA				
No	110 (73.3)	103 (93.6)	7 (6.4)	0.01
Yes	40 (26.7)	32 (80)	8 (20)	
Left main > 50%				
No	112 (74.6)	104 (92.9)	8 (7.1)	0.01
Yes	38 (25.4)	31 (81.6)	7 (18.4)	
LAD disease				
No	15 (10)	15 (100)	0 (0)	0.17
Yes	135 (90)	120 (88.9)	15 (11.1)	
PDA				
No	20 (13.3)	20 (100)	0 (0)	0.1
Yes	130 (86.7)	115 (88.5)	15 (11.5)	

DM: Diabetes mellitus, COPD: chronic obstructive pulmonary dusease, PTCA: Percutaneous transluminal coronary angiography, LAD: Left anterior descending artery, P value < 0.05 is significant, while (*) means highly significant P value.

Table 3 showed univariate analysis for use of temporary pacing according to operative data where a statistically significant difference between both groups regarding the operative data such as need for inotropes to leave OR, pacing required to come off CPB, or cardioversion required in OR, use of IABP, or antiarrhythmics needed to leave OR, cardiopulmonary bypass and aortic cross-clamp times. 20% of patients who required inotropes to leave the OR needed pacing. All patients who were paced to come off CPB needed also temporary pacing in the postoperative care. Only 22.45% of patients where CPB time was more than 100 minutes were also paced, 22.2% of patients with aortic cross clamp time more than 65 minutes needed pacing postoperatively, 25% of patients who needed support with IABP were paced postoperatively, 73.3% of patients who needed cardioversion in OR were paced postoperatively and 60% of patients who needed antiarrhythmics to leave OR also needed temporary pacing in postoperative care.

Table 4 showed univariate analysis for use of temporary pacing according to postoperative data where postoperative Stroke (p-value = 0.003) and postoperative new onset AF (p-value = 0.001) showed significant difference between both groups. We had only one patient complicated postoperatively by stroke and

Table 3. Univariate Analysis for use of temporary pacing according to operative data.

Variables n (%)	Total n = 150	Group A (n = 135)	Group B (n = 15)	P-value
Inotropes to leave OR				
No	90 (60)	87 (96.7)	3 (3.3)	0.00*
Yes	60 (40)	48 (80)	12 (20)	
Pacing required to come off CPB				
No	144 (96)	135 (93.75)	8 (6.25)	0.00*
Yes	7 (4)	0 (0)	7 (100)	
CPB time				
<100 min	101 (67.4)	97 (96.03)	4 (3.96)	By FE P < 0.0001*
>100 min	49 (32.6)	38 (77.55)	11 (22.45)	
Aortic cross clamp time				
<65 min	105 (70)	100 (95.2)	5 (4.8)	0.001*
>65 min	45 (30)	35 (77.8)	10 (22.2)	
IABP				
No	130 (86.7)	120 (92.3)	10 (7.7)	0.01
Yes	20 (13.3)	15 (75)	5 (25)	
Cardioversion required in OR				
No	135 (90)	131 (97.03)	4 (2.93)	0.00*
Yes	15 (10)	4 (26.7)	11 (73.3)	
Antiarrhythmics needed to leave OR				
No	135 (90)	129 (95.55)	6 (4.44)	0.00*
Yes	15 (10)	6 (40)	9 (60)	

OR: Operative room, CPB: Cardiopulmonary bypass, IABP: Intraaortic balloon pump, P value < 0.05 is significant, (*) means highly significant P value.

needed pacing, patients who developed postoperative new onset AF were only five and all needed pacing. 33.4% of patients who had perioperative MI needed also pacing.

The predictors of TCP in the multivariate analysis were shown in Table 5 where old age (Odds Ratio = 12, p-value = 0.001), D.M (Odds Ratio = 26, p-value = 0.0001), history of arrhythmias (Odds Ratio = 27, p-value = 0.002), pacing to come off CPB (Odds Ratio = 16, p-value = 0.0001), cardioversion in OR (Odds Ratio = 22, p-value = 0.0001), use of antiarrhythmics to leave OR (Odds Ratio = 12, p-value = 0.0001), perioperative new onset AF (Odds Ratio = 13, p-value = 0.0003), and CPB time >100 min (Odds Ratio = 4.8, p-value = 0.009) were all significantly more likely to need TCP.

So, Age more than 65 years, DM, history of arrhythmia, pacing to come off CPB, CPB time more than 100 minutes, need for cardioversion to leave OR, need for antiarrhythmics in OR, and perioperative new onset AF, were all factors associated with temporary cardiac pacing in the postoperative care.

Table 4. Univariate analysis for use of temporary pacing according to postoperative data.

Variables	Total (n = 150)	Group A (n = 135)	Group B (n = 15)	P-value
Postoperative Stroke				
No	149 (99.3)	135 (90.6)	14 (9.4)	0.003*
Yes	1 (0.7)	0 (0)	1 (100)	
Postop New onset AF				
No	145 (96.6)	135 (93.1)	10 (6.9)	0.001*
Yes	5 (3.4)	0 (0)	5 (100)	
Perioperative MI				
No	147 (98)	133 (90.5)	14 (9.5)	0.18
Yes	3 (2)	2 (66.6)	1 (33.4)	

AF: Atrial Fibrillation, MI: Myocardial infraction, P value < 0.05 is significant, (*) means highly significant P value.

Table 5. Multivariate Analysis of factors associated with temporary cardiac pacing.

Variable	Odds Ratio (OR)	Confidence Interval (CI)	P-value
Age >65 years	12	2.6:56	0.001
Diabetes Mellitus	26	5.5:122	<0.0001
History of arrhythmias	27	3.5:212.5	0.002
Pacing to come off CPB	16	4.5:57	0.0001
CPB time >100 min	4.8	1.5:16	0.009
Cardioversion in OR	22	6.3:77.8	<0.0001
Antiarrhythmics to leave OR	12	3.7:38.4	<0.0001
Perioperative New onset AF	13	3.2:52.5	0.0003

4. Discussion

Temporary pacemakers are useful in the intra- and postoperative management of cardiac surgery patients in some cases. Although this procedure is generally safe, a small percentage of patients may experience complications during insertion, postoperative pacing, pacemaker wire removal, or if temporary wires are retained inside the body [9].

Infection, myocardial damage, perforation, tamponade, and disruption of coronary anastomoses are all complications of epicardial wires [10] [11]. Unfortunately, these complications have never been adequately measured. Park *et al*. [12] observed an artificial structure in the right heart of a 73-year-old man who had undergone CABG with retained pacing wires 10 months postoperatively by routine echocardiography in an outpatient clinic.

Every cardiac surgery centre has its protocol of placing temporary epicardial pacing wires in isolated CABG patients.

In our study we used ventricular wires in (90%) and both atrial and ventricular in (10%), for patients in the study mostly in those having AV blocks.

Numerous studies have revealed that the vast majority of patients never require pacing. In light of this, some centers restrict the use of epicardial wires to patients who require pacing immediately prior to chest closure, such as bradycardia with low cardiac output, nodal or junctional arrhythmias, or AV block [8].

In our study, a number of patients had significant comorbidities including diabetes mellitus in 26.7% (40/150), hypertension in 53.3% (80/150). 66.7% (100/150) had a history of a preoperative angina and 70% (105/150) were having NYHA class III or IV. All patients underwent standard isolated coronary artery bypass graft utilizing cardiopulmonary bypass. We used inotropic support only when it was required. Temporary wires have been used in the perioperative period to improve patient haemodynamics as well as to suppress malignant arrhythmias [13].

Arrhythmias are a well-known complication of cardiac surgery, and they are a major cause of morbidity and length of stay in the hospital. Early postoperative arrhythmias are uncommon, and little is known about their occurrence, risk factors, and management. Atrial fibrillation is the most common rhythm abnormality in this situation. Although postoperative atrial fibrillation is frequently self-limiting, it may necessitate anticoagulation and a rate or rhythm control plan. In the absence of reversible reasons, sustained ventricular arrhythmias throughout the recovery period following heart surgery may necessitate immediate treatment and a long-term prevention surgery. Temporary pacing wires can be used to manage transient bradyarrhythmias during surgery, but significant and persistent atrioventricular block or sinus node dysfunction can occur, necessitating permanent pacing [14].

In our study, Of the 15 patients who were paced, only one required a permanent pacemaker. Pacing was done because of postoperative sinus bradycardia in

six patients, atrioventicular block in two, bundle branch block in four, and cardiac arrest in two patients. Univariate and multivariate analysis determined specific risk factors that were associated with temporary pacing in the perioperative period. Importantly, old age > 65 years, diabetes mellitus, history of arrhythmias, pacing to come off CPB, CPB time > 100 min, cardioversion to leave OR, antiarrhythmics when leaving leave OR and new onset of atrial fibrillation (AF), were all found to be significant predictors of the need for cardiac pacing. Each of these clinical entities was associated with significant odds ratios.

TCP was primarily required in the presence of a mechanical injury to the conduction system caused by operative procedures performed in close physical proximity to the atrioventricular node or the His bundle, or an ischemic injury to the conduction system caused by cardioplegic arrest. Both mechanisms have the potential to exacerbate pre-existing conduction defects or to cause new ones [15].

In this study, patients who had PMWs inserted were more than 65 years old were more likely to be paced by both univariate and multivariate analysis. Some studies found that gender was not a predictor of TCP, A finding that was consistent with our study [16] [17].

Atrial fibrillation has been reported in up to 15% to 40% of patients in the early postoperative period after CABG [18]. The incidence of postoperative AF in patients undergoing CABG consistently increases with older age [17].

During the last decade, routine insertion of PMWs in CABG surgery being on-pump or a beating heart has been well studied and many centres turned to limit their use [15]. We limited the insertion of PMWs in young age with minimal comorbidities, after separation from CPB in sinus rhythm, and hemodynamically stable on minimal support, including recently, patients in sinus bradycardia who respond to minimal doses of beta-adrenergic drugs. These limitations for PMWs insertion were according to the surgeon's decision whose main purpose was to safely select patients, avoid the above mentioned complications and was according to the data in the previous reports.

In the study done by Bethea *et al*., [18], old age, diabetes mellitus, preoperative arrhythmias, pacing utilized at separation from CPB, were found to be predictors of the need for cardiac pacing in CABG in both univariate and multivariate analysis, This was consistent with our study.

Only 10% (15/150) of patients required pacing which is near from the international figure, (8.6%) [19]. There were no major morbidities or mortalities related to temporary pacing wires in this study in the early postoperative period.

In the study done by Asghar *et al*., [20], analysis identified age, preoperative arrhythmia (especially Bundle Branch Block), pacing utilized at separation from bypass, and use of antiarrhythmics on leaving the operating room, as predictors of the need for postoperative pacing. This was consistent with that reported in our study.

We found that the use of inotropic drugs upon leaving the operating room was a predictor of the requirement for postoperative pacing in both univariate

and multivariate analysis. Sinoatrial node automaticity and AV nodal conduction time are reported to be improved by inotropic drugs. Dobutamine has been shown to cause ventricular ectopic activity in 3 - 15 percent of patients in humans. Dopamine, which is more likely to be associated with dose-related sinus tachycardia or AFib, has shown mixed outcomes [13].

Cote *et al*., found that older age, female sex, preoperative renal failure, lower ejection fraction (EF), preoperative arrhythmia, preoperative use of calcium channel blockers, and longer cross-clamp times were risk factors for pacing in the isolated coronary artery bypass patients [21].

The small sample size and the inherent design of observational studies, where patients were not randomized to receive pacing wires, were the limitations of the study.

This study found particular patient characteristics linked to the use of pacing wires after surgery, and as a result of this information, our hospital's practice has changed, with fewer pacing wires being implanted.

5. Conclusion

This study emphasized specific predictors associated with postoperative pacing after CABG. Predictors of TCP after CABG include old age >65 years, diabetes mellitus, history of arrhythmias, pacing to come off CPB, CPB time >100 min, cardioversion to leave OR, antiarrhythmics to leave OR and new onset of AF. By selectively using temporary epicardial pacing wires, patient morbidity can be minimized and at the same time, decrease postoperative length of stay, thus improving hospital cost of stay.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Fishberger, S.B., Rossi, A.F., Bolivar, J.M., Lopez, L., Hannan, R.L. and Burke, R.P. (2008) Congenital Cardiac Surgery without Routine Placement of Wires for Temporary Pacing. *Cardiology in the Young*, **18**, 96-99. https://doi.org/10.1017/S1047951107001424

[2] Imren, Y., Zor, H. and Tasoglu, I. (2005) Ventricular Fibrillation Following Removal of Temporary Epicardial Pacemaking Wires. *Cardiology in the Young*, **15**, 654-655. https://doi.org/10.1017/S1047951105001861

[3] Moltedo, J.M., Rosenthal, G.L., Delaney, J., Mello, D. and Snyder, C.S. (2007) The Utility and Safety of Temporary Pacing Wires in Postoperative Patients with Congenital Heart Disease. *The Journal of Thoracic and Cardiovascular Surgery*, **134**, 515-516. https://doi.org/10.1016/j.jtcvs.2007.01.091

[4] Ceresnak, S.R., Pass, R.H., Starc, T.J., Hordof, A.J., Bonney, W.J., Mosca, R.S. and Liberman, L. (2011) Predictors for Hemodynamic Improvement with Temporary Pacing after Pediatric Cardiac Surgery. *The Journal of Thoracic and Cardiovascular Surgery*, **141**, 183-187. https://doi.org/10.1016/j.jtcvs.2010.03.048

[5] Kapoor, A., Syal, S., Gupta, N. and Gupta, A. (2011) Right Paracardiac Mass Due to Organized Pericardial Hematoma around Retained Epicardial Pacing Wires Following Aortic Valve Replacement. *Interactive Cardiovascular and Thoracic Surgery*, **13**, 104-106. https://doi.org/10.1510/icvts.2010.264853

[6] Smith III, D.E., DeAnda Jr, A., Towe, C.W. and Balsam, L.B. (2013) Retroaortic Abscess: An Unusual Complication of a Retained Epicardial Pacing Wire. *Interactive Cardiovascular and Thoracic Surgery*, **16**, 221-223. https://doi.org/10.1093/icvts/ivs456

[7] Abu-Omar, Y., Guerrieri-Wolf, L. and Taggart, D.P. (2006) Indications and Positioning of Temporary Pacing Wires. *Multimedia Manual of Cardio-Thoracic Surgery*, **2006**, 1248-1240. https://doi.org/10.1510/mmcts.2005.001248

[8] Puskas, J.D., Sharoni, E., Williams, W.H., Petersen, R., Duke, P. and Guyton, R.A. (2003) Is Routine Use of Temporary Epicardial Pacing Wires Necessary after Either OPCAB or Conventional CABG/CPB? *Heart Surgery Forum*, **6**, 488-491.

[9] Elmistekawy, E. (2019) Safety of Temporary Pacemaker Wires. *Asian Cardiovascular and Thoracic Annals*, **27**, 341-346. https://doi.org/10.1177/0218492319833276

[10] Timothy, P.R. and Rodeman, B.J. (2004) Temporary Pacemakers in Critically Ill Patients: Assessment and Management Strategies. *AACN Advanced Critical Care*, **15**, 305-325. https://doi.org/10.1097/00044067-200407000-00002

[11] Bojar, R.M. (2020) Manual of Perioperative Care in Adult Cardiac Surgery. John Wiley & Sons, Hoboken. https://doi.org/10.1002/9781119582540

[12] Park, S., Lee, J., Byun, Y.S., Jung, I.H. and Chung, E. (2020) Temporary Epicardial Pacing Wire Migration into the Right Heart, 10 Months after Coronary Artery Bypass Surgery. *The Heart Surgery Forum*, **23**, E168-E170. https://doi.org/10.1532/hsf.2781

[13] Chung, E.H. and Martin, D.T. (2010) Management of Postoperative Arrhythmias. In: *Surgical Intensive Care Medicine*, Springer, Boston, 209-227. https://doi.org/10.1007/978-0-387-77893-8_21

[14] Peretto, G., Durante, A., Limite, L.R. and Cianflone, D. (2014) Postoperative Arrhythmias after Cardiac Surgery: Incidence, Risk Factors, and Therapeutic Management. *Cardiology Research and Practice*, **2014**, Article ID: 615987. https://doi.org/10.1155/2014/615987

[15] AlWaqfi, N.R., Ibrahim, K.S., Khader, Y.S. and Baker, A.A. (2014) Predictors of Temporary Epicardial Pacing Wires Use after Valve Surgery. *Journal of Cardiothoracic Surgery*, **9**, 1-7. https://doi.org/10.1186/1749-8090-9-33

[16] Ferrari, A.D.L., Süssenbach, C.P., Guaragna, J.C.V.D.C., Piccoli, J.D.C.E., Gazzoni, G.F., Ferreira, D.K. and Goldani, M.A. (2011) Atrioventricular Block in the Postoperative Period of Heart Valve Surgery: Incidence, Risk Factors and Hospital Evolution. *Brazilian Journal of Cardiovascular Surgery*, **26**, 364-372. https://doi.org/10.5935/1678-9741.20110010

[17] Elahi, M.M., Khan, J.S. and Matata, B.M. (2006) Deleterious Effects of Cardiopulmonary Bypass in Coronary Artery Surgery and Scientific Interpretation of Off-Pump's Logic. *Acute Cardiac Care*, **8**, 196-209. https://doi.org/10.1080/17482940600981730

[18] Bethea, B.T., Salazar, J.D., Grega, M.A., Doty, J.R., Fitton, T.P., Alejo, D.E., Baumgartner, W.A., *et al*. (2005) Determining the Utility of Temporary Pacing Wires after Coronary Artery Bypass Surgery. *The Annals of Thoracic Surgery*, **79**, 104-107. https://doi.org/10.1016/j.athoracsur.2004.06.087

[19] Imren, Y., Benson, A.A., Oktar, G.L., Cheema, F.H., Comas, G. and Naseem, T.

(2008) Is Use of Temporary Pacing Wires Following Coronary Bypass Surgery Really Necessary? *Journal of Cardiovascular Surgery*, **49**, 261.

[20] Asghar, M.I., Khan, A.A., Iqbal, A., Arshad, A. and Afridi, I. (2009) Placing Epicardial Pacing Wires in Isolated Coronary Artery Bypass Graft Surgery—A Procedure Routinely Done but Rarely Beneficial. *Journal of Ayub Medical College Abbottabad*, **21**, 86-90.

[21] Cote, C.L., Baghaffar, A., Tremblay, P. and Herman, C.R. (2020) Prediction of Temporary Epicardial Pacing Wire Use in Cardiac Surgery. *Journal of Cardiac Surgery*, **35**, 1933-1940. https://doi.org/10.1111/jocs.14870