

Case Report

Heart Rate Profiles of Patients Developing Atrial Fibrillation Following Coronary Artery Bypass Grafting: Consideration for a Threshold of Eighty Beats Per Minute or Less Postoperatively

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Abstract

Background: Post-Operative Atrial Fibrillation (POAF) is the most common dysrhythmia following open-heart surgery. The mechanisms and risk factors for its development are multi-factorial including mechanical effects from the surgery itself, biochemical alterations, influences from medications, and patient comorbidities among others. In an attempt to better understand and manage the problem, a retrospective review of Coronary Artery Bypass Grafting (CABG) who developed POAF was undertaken with a specific focus on the heart rate just prior to the dysrhythmia.

Methods: All isolated CABG cases from January 1, 2017 through December 31, 2022 were reviewed using the Society of Thoracic Surgery Database from our institution. Patient demographics were obtained along with co-morbidities and determination of whether or not the patient received beta-blocker prior to the CABG. The interval between the operation and the development of POAF was calculated and the heart rate recorded just prior to its occurrence. All patients received beta-blocker postoperatively unless contraindicated. Treatment of POAF, when it occurred, was protocolized to beta-blocker and/or calcium blocker for rate control and amiodarone as the anti-arrhythmic of choice.

Results: There were 523 isolated CABG cases performed during the study period. More than ninety-five percent were conducted with a beating heart technique utilizing cardiopulmonary bypass; the remainder were either completely off-pump or traditional with aortic cross-clamping and cardioplegia. Overall, sixty-eight patients developed POAF (13.0%). The mean duration from surgery to POAF was three days. The heart rate was >80 bpm in fifty patients prior to POAF (73.5%) and <80 bpm in eighteen patients (26.5%). Rapid POAF (defined as a HR >100) occurred in fifty-nine patients (86.8%). The average length of stay for the POAF patients was 9.4 days. Only one patient failed to convert to normal sinus rhythm at the time of discharge. There were no strokes associated with POAF.

Conclusion: The majority of CABG patients in this study who developed POAF did so with heart rates greater than 80 bpm. Efforts to mitigate this occurrence with aggressive heart rate control are suggested.

Introduction

Post-Operative Atrial Fibrillation (POAF) is the most common dysrhythmia following open-heart surgery, occurring in 20%-40% of patients [1]. The mechanisms and risk factors for its development are multi-factorial including mechanical effects from the surgery itself, biochemical alterations, influences from medications, patient demographics (e.g., advanced age) and co-morbidities. Regardless of these factors, the author (L.S.) has observed that the development of POAF is often preceded by elevated heart rates above 80 beats per minute. In an attempt to quantify this observation, a retrospective

review of coronary artery bypass patients was undertaken focusing on the heart rates prior to the development of POAF.

Methods

All isolated CABG cases from January 1, 2017 through December 31, 2022 were reviewed using the Society of Thoracic Surgery Database from our institution. Patient demographics were obtained along with co-morbidities and beta-blocker administration prior to the CABG procedure. Patients with permanent pacemakers and patients with known chronic or paroxysmal Atrial Fibrillation (AF) were excluded. The interval between the operation and the development of POAF was calculated and the Heart Rate (HR) recorded just prior to its occurrence. For tabulation purposes, the HR was designed as greater than (>) or less than (<) 80 beats per minute (bpm). All patients received beta-blocker post-operatively unless contraindicated by bradycardia (i.e., HR <50 bpm) associated with hypotension (i.e., BP <90 mmHg), hypotension irrespective of heart rate, heart block, or new need for temporary electrical pacing. Treatment of POAF was protocolized to beta-blocker and/or calcium channel blocker for rate control and amiodarone as the anti-arrhythmic of choice. Electrical cardioversion was reserved for rapid POAF associated with hemodynamic instability.

Results

There were 523 isolated CABG cases performed during the study period. More than ninety-five percent were conducted with a Pump-

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Assisted Direct Coronary Artery Bypass (PAD-CAB) beating heart technique; the remainder were either completely Off-Pump (OP-CAB) or Traditional with Aortic Cross-Clamping and Cardioplegia (TRAD-CAB). Patient demographics were collected and appear in Table 1.

Overall, sixty-eight patients developed POAF (13.0%). The incidence of POAF by calendar year is illustrated in Table 2. The mean duration from surgery to POAF was three days (range: 1-16 days) Figure 1. Sixty-three (92.5%) of patients received a beta-blocker within twenty-four hours of surgery. Sixty-six (97.1%) patients received and were discharged with beta-blocker therapy postoperatively. The heart rate was >80 bpm in fifty patients prior to the development of POAF (73.5%). Atrial Fibrillation with RVR occurred in fifty-nine patients (86.8%). No patient required electrical cardioversion. Only one patient failed to convert to normal sinus rhythm at the time of discharge. The average length of stay for the POAF patients was 9.4 days. There were no strokes associated with POAF.

Table 1: Demographics and Findings.

Demographic et al.,	Number or Mean Value	Range or Percent
Age	67.3 YRS	48 - 88 YRS
MALE	45	66%
DM	34	50%
HTN	64	94%
ESRD	9	13.20%
EF	48%	15%-70%
BETA-Blocker W/IN 24 HRS Of Cabg	63	92.60%
HR >80 BPM Prior To Poaf	50	73.50%
HR >100 With Poaf	59	86.80%
Post OP Length of Stay (LOS)	9.4 Days	4-51 Days

Table 2: Post-Operative Atrial Fibrillation (Po-Afib) by Calendar Year.

Calendar Year	Number of Cabg Cases	POAF: NO. & %
2017	86	16 (18.6%)
2018	99	13 (13.1%)
2019	101	12 (11.9%)
2020	73	10 (13.7%)
2021	86	13 (15.1)
2022	78	4 (5.1%)
Cumulative	523	68 (13.0%)

Discussion

Atrial Fibrillation following open-heart surgery has plagued clinicians since the specialty was instituted. Efforts to mitigate the development of POAF and manage it remain an ongoing endeavor. An historical perspective regarding the management of POAF in CABG patients was published in 1999 with hints toward prophylactic protocols with anti-arrhythmic as well as the possibility of a temporary internal atrial defibrillator [2], the latter non-existent. Six years later, adoption of amiodarone and early cardioversion for refractory POAF was suggested to reduce the need for proper anticoagulation in cases of sustained atrial fibrillation in the postoperative period [3]. During these years, as well as those that followed, modifications in the surgical approach were made with the hope of reducing POAF-one of those methods was avoidance of cardiopulmonary bypass. In an effort to answer this question, Archbold and Curzen reviewed the incidence of POAF in patients undergoing OP-CAB [4]. Despite examining the data, they concluded that: "It is uncertain whether a reduction in the incidence of postoperative AF can be added to this list (of potential advantages of OP-CAB). More robust data are required".

Predictors of POAF have also been examined by numerous

investigators in retrospective reviews in an attempt to identify risk factors that may predispose to POAF. In 2011, for example, analysis of Heart Rate Variability (HRV) in OP-CAB patients was studied by Chamchad and colleagues [5]. They concluded that OP-CAB not only failed to protect against POAF, but that non-linear HRV analyses provided little value in predicting POAF in CABG patients. In 2014, a large study from three European university hospitals established a bedside tool for predicting the risk of POAF after cardiac surgery [5,6]. The POAF score was calculated by summing weighting points for each dependent AF predictor (of which there were many). Remarkably, preoperative drug regimen did not influence the development of POAF. The use of β -blockers, calcium antagonists, angiotensin-converting enzyme inhibitors, and statins, for example, were not associated with a decreased POAF risk. Although these results were interesting, neither the conclusions from the study nor the adoption of the POAF Score are universally accepted.

Many other investigators have identified risk factors for the development of POAF, some of which are listed below [7- 13].

- a) Advanced age
- b) Enlarged Left Atrium (LA) volume
- c) Low ejection fraction
- d) Combined surgeries
- e) Prolonged ventilation time
- f) Hypertension
- g) Euro SCORE I
- h) Creatinine clearance values
- i) Hematological indices
- j) Preoperative stable angina
- k) Low cardiac output syndrome
- l) Use of cardiopulmonary bypass
- m) CHA2DS2-VASc Score

Other factors, such as COPD, electrolyte and acid/base abnormalities, renal dysfunction/failure, and others (e.g., inotropes and vasopressors) have been associated with POAF, but vary in the magnitude of their influence. The interpretation from these studies, in the author's opinion (L.S.), is that there are many factors that contribute to this common arrhythmia and that the clinician is in a position to moderate some of them, but not all of them.

- a) The data from this study suggests that the heart rate itself plays some role in the development (or lack of development) of POAF independent of other variables. In particular, heart rate above 80 bpm appears to predispose patients to POAF more so than heart rates less than 80 bpm. Whether it is the heart rate itself or the factors contributing to the heart rate is beyond the scope of this study. However, irrespective of the mechanism for the heart rate, it appears that there is an association with POAF. A typical patient profile of this observation is illustrated in Figure 1 and 2. Note the development of POAF on Postoperative Day (POD) 2 and the heart rates: Normal Sinus Rhythm (NSR) with a HR <80 bpm in the early postop period followed by an escalation of the HR >80 bpm when AF occurred. Although not specifically

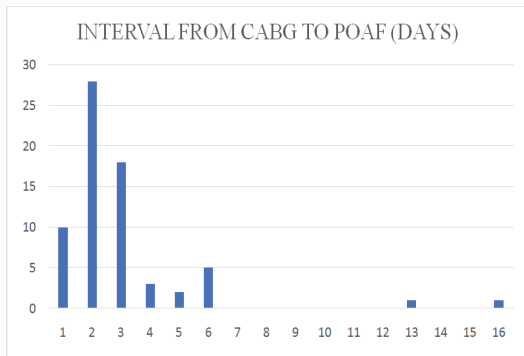


Figure 1: Interval from CABG to POAF.

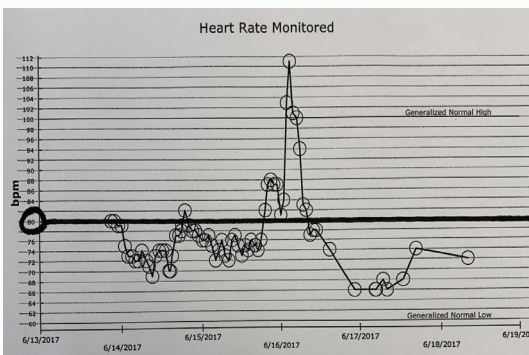


Figure 2: Typical POAF Profile (Date of Surgery 6.13.2017 and Date of POAF 6.16.2017).

captured in the analysis of the study patients, the authors observed several features in the POAF patients: an increased presence of premature atrial and/or ventricular contractions (PAC or PVC), signs of pericarditis (e.g., friction rub, diffuse ST segment elevation), and an occasional temporary hold on beta-blocker administration for transient hypotension prior to the POAF development. As these observations became more apparent, efforts to address them became more pronounced on daily rounds and protocols. For example, withholding beta-blocker was discouraged and relative hypotension was treated with alpha-agonists and/or volume to avoid discontinuation of the beta blocker; colchicine was routinely administered if signs of pericarditis were present and sometimes even used prophylactically. As a result of these more aggressive maneuvers, the most recent data from calendar year 2022 showed a POAF incidence of only 5.1% (Table 2). Lastly, although it was not necessary to perform electrical cardioversion to restore NSR in any of the POAF patients nor did any of them suffer a related stroke, we have added Left Atrial Appendage (LAA) ligation with the AtriClip device (Atricure Inc., Mason, OH) to patients with a CHA₂DS₂-VASc Score >3.

In summary, this study adds to the literature on the factors associated with the development of POAF in CABG patients. Based on the results, our recommendation is to attempt maintaining a heart rate below 80 bpm in the postoperative period and to use beta-blockade to do so. Initiation of alpha agents and/or volume to maintain adequate blood pressure to avoid withholding beta-blocker in patients with relative hypotension as well as the liberal use of colchicine to treat or provide prophylaxis against pericarditis are strategies to consider.

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