Original Article

POSTOPERATIVE CARDIAC ARREST DUE TO CARDIAC SURGERY COMPLICATIONS

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ABSTRACT

Objectives: To examine the role of anesthetists in the management of cardiac arrest occurring in association with cardiac anesthesia.

Methodology: In this retrospective study we studied the potential performances for each of the relevant incidents among 712 patients undergoing cardiac operations at Golestan and Naft Hospitals Ahwaz between November 2006 and July 2008.

Results: Out of total 712 patients undergoing cardiac surgery, cardiac arrest occurred in 28 cases (3.9%) due to different postoperative complications. This included massive bleeding (50% of cardiac arrest cases, 1.9% of patients); pulseless supra ventricular tachycardia (28.5% of cardiac arrest cases, 1.1% of patients); Heart Failure (7% of cardiac arrest cases, 0.2% of patients); Aorta Arc Rapture (3.5% of cardiac arrest cases, 0.1% of patients); Tamponade due to pericardial effusion (3.5% of cardiac arrest cases, 0.1% of total patients); Right Atrium Rupture (3.5% of cardiac arrest cases, 0.1% of patients) were detected after cardiac surgery. Out of 28 cases 7 deaths occurred (25% of cardiac arrest cases, 0.1% of patients). The most prevalent reason for cardiac arrest during post operative phase was massive bleeding (50%) followed by pulseless supra ventricular tachycardia (28.5%). Six patients had some morbidity and the remaining 15 patients recovered.

Conclusion: There are often multiple contributing factors to a cardiac arrest under cardiac anesthesia, as much a complete systematic assessment of the patient, equipment, and drugs should be completed. We also found that the diagnosis and management of cardiac arrest in association with cardiac anesthesia differs considerably from that encountered elsewhere.

KEY WORDS: Cardiac anesthesia, Arrest, Pulseless supra ventricular tachycardia, Massive bleeding.

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INTRODUCTION

Many studies of cardiac arrest in association with anesthesia have been published recently. Five major studies among them includes: over five hundred thousand cases of all ages in the USA,[1,2] one million pediatric cases in the USA,[3] 2.3 million cases in Japan,[4] and over one hundred thousand in France.[5] The findings are remarkably consistent. Cardiac arrest attributable to anesthesia occurred at the rate of between 0.5 and 1 case per 10 000 cases overall and at

the rate of 1.4 per 10 000 cases for the pediatric series; 55% of these were in children less than one year of age. The overall rate of cardiac arrest is up to 10 times higher than this, with uncontrolled bleeding, technical surgical problems, extensive co-morbidity, and advanced age all featuring prominently.

In-hospital mortality in the anesthesia related group was considerably lower than the surgical rate, with 80% of these patients leaving hospital fully recovered. Most of the anesthesia related cardiac arrests were thought to be preventable and to have involved human error or inadequate human resources. Anesthesia in cardiac surgery is one of the most difficult fields of anesthesiology. The most difficult patients, whose adaptive reserve of cardiovascular system is very poor, are met in this field. These patients have ischemic heart disease and arterial hypertension often. All these factors increase the risk of anesthesia. So it is very important to choose medications thoroughly and save the compensatory mechanisms of cardiovascular system under conditions of surgical stress.[6,7]

Arrhythmias are frequent after cardiac surgery. The most common arrhythmias are supraventricular.[8-12] Proposed hypotheses to explain the high incidence of atrial fibrillation (AF) include the increased adrenergic drive in the postoperative period, atrial ischemia/necrosis associated with atriotomy, incomplete or prolonged atrial cardioplegia, and electrolyte abnormalities during and following cardiopulmonary bypass or pericarditis. De novo ventricular arrhythmias following cardiac surgery is an uncommon but serious complication.[13-18] Some patients are clearly at risk for ventricular arrhythmias. The patients included in the coronary artery bypass grafting (CABG) patch trial,[19] for example, had an ischemic dilated cardiomyopathy with an ejection fraction (EF) <0.36 and an abnormal signal-averaged electrocardiograph (ECG). Significant advances in perioperative medical management and surgical techniques have both contributed to decreasing the incidence of severe bleeding in patients undergoing cardiac surgery. Refractory bleeding secondary to severe coagulopathy, however, still occurs occasionally in patients undergoing complex cardiac procedures.[20,21] The correction of this condition requires the administration of large amount of blood products, which has limited efficacy and is often associated with increased postoperative morbidities and mortality.[21] The aim of this study was to evaluate the causes of severe complications occurring after cardiac surgery.

METHODOLOGY

The study was approved by the Ethics Committee of the Ahwaz Jondishapour University of Medical Sciences and written conset was taken. We retrospectively and prospectively studied 712 patients undergoing cardiac operations at Golestan and Naft Hospitals Ahwaz between November 2006 and July 2008. Twenty eight patients (22 men, 6 women; age 42–71 years, mean 57.6 ± 11.02 years) developed postoperative cardiac arrest in the study group.

Data Collection: Data was obtained on patient characteristics and details of the mode and timing of presentation, the relevant investigations, and treatment received were also recorded. The information collected regarding the cardiac operation included: type of operation, degree of urgency, method of myocardial protection, bypass time, and cross-clamp time. Intensive care notes were reviewed to find out time to extubation and length of stay in the intensive care unit. A note was made of inotrope requirements, intra-aortic balloon pump support, perioperative arrhythmias, and any prolonged periods of hypotension.

Left ventricular function was assessed angiographically and graded by use of criteria of the Coronary Artery Surgery Study.[22] Carotid artery duplex scanning was performed as previously described in patients>65 years old and in younger patients with carotid artery bruits, including transient ischemic episodes.[23] Carotid artery stenosis was graded as insignificant or no disease (luminal narrowing<50%); moderate disease (narrowing >50% but <80%); severe disease (narrowing >80 but <99%); and complete occlusion. For the analysis, severe disease

and complete occlusion were combined. The atherosclerosis was graded independently by two blinded investigators as insignificant or no atherosclerosis; mild atherosclerosis (intimal thickening <3.0 mm without intimal irregularities); or moderate to severe atherosclerosis (e"3.0 mm thickening with diffuse irregularities, large mobile or protruding atheromata, ulcerated plaques, and/or thrombi).[24-28] Complications documented included myocardial infarction (new Q waves on the 12-lead ECG or ratio of fractionated lactic dehydrogenase [LDH1/LDH2] >1 during the first 72 hours), low cardiac output syndrome (cardiac index of <2.0 $L{\cdot}min^{-1}{\cdot}m^{-2}$ for >24 hours after surgery regardless of treatment), renal failure (requiring dialysis), and death. Continuous telemetry ECG monitoring was performed until the time of hospital discharge to document atrial fibrillation.

Statistical Analysis: Continuous data are expressed as mean values ± SD. Univariate comparison was made by the *t* test or chi-square analysis when appropriate. A p- value <0.05 was considered significant.

RESULTS

Demographic and other characteristics of all 712 study patients are listed in (Table-I). Cardiac arrest occurred in 28 patients (3.9%) due to different postoperative complications which included massive bleeding (50% of cardiac arrest cases, 1.9% of patients); pulseless supra ventricular tachycardia (28.5% of cardiac arrest cases, 1.1% of patients); Heart Failure (7% of cardiac arrest cases, 0.2% of patients); Aorta Arc Rapture (3.5% of cardiac arrest cases, 0.1% of patients); Tamponade due to pericardial effusion (3.5% of cardiac arrest cases, 0.1% of patients); Right Atrium Rupture (3.5% of cardiac arrest cases, 0.1% of patients) were detected after cardiac surgery (Fig-1). Unfortunately, out of 28 cases 7 deaths occurred (25% of cardiac arrest cases, 0.1% of patients) in patients with cardiac arrest. The most prevalent reason for cardiac arrest during post operative phase was massive bleeding (50%) followed by pulseless supra ventricular tachycardia (28.5%). Six patients had some morbidity and the remaining 15 patients recovered. There were no deaths in the remaining 15 patients (one suffered temporary morbidity but was ''fully recovered'' at 48 hours). Pre-existing medical or surgical disease was one of the aetiological factors in four deaths, surgery in two, and drugs in one. Characteristics of the 28 patients who developed cardiac arrest in postoperative phase has been shown in (Table-II). Fig-2 presents the numbers

Table-I: Characteristics of the 712 Patients undergoing Cardiac Surgery (n = 712)

Characteristics	*Number (%)*
Age, years (mean ± SD)	62 ± 12
Male/female	527/185
Diabetes mellitus	226 (31.7)
Hypertension	389 (54.6)
Hyperlipidemia	214 (30)
Smoking	451 (63.3)
Pulmonary disease	228 (32)
Carotid artery stenosis	
Moderate right stenosis	112 (15.7)
Severe right stenosis	84 (11.8)
Moderate left stenosis	210 (29.5)
Severe left stenosis	87 (12.2)
Ascending aorta atherosclerosis	
Normal	435 (61.1)
Mild	145 (20.4)
Moderate/Severe	132 (18.5)
Coronary stenosis	
None	141 (19.8)
One vessel	225 (31.6)
Two vessel	165 (23.2)
Three vessel	181 (25.4)
Types of surgery	
CABG	654 (92)
CABG/valvular	25 (3.5)
CABG/carotid endarterectomy	33 (4.5)
Cardiopulmonary bypass time, min	119 ± 43
Cross-clamp time, min	79 ± 28

Moderate and severe carotid artery stenosis refer to stenosis of >50% but <80% and >80% to <99%, respectively.

Table-II: Characteristics of the 28 patients who developed cardiac arrest in postoperative phase (n = 28)

Characteristics	*Number (%)*
Age, years (mean ± SD)	57.6 ± 11
Male/female, n	22/6
Diabetes mellitus	14 (50)
Hypertension	20 (71.4)
Hyperlipidemia	18 (64.2)
Smoking	11 (39.2)
Pulmonary disease	10 (35.7)
Carotid artery stenosis	
Moderate right stenosis	12 (42.8)
Severe right stenosis	4 (14.2)
Moderate left stenosis	10 (35.7)
Severe left stenosis	2 (7.1)
Ascending aorta atherosclerosis	
Normal	0
Mild	5 (17.8)
Moderate/Severe	2 (7.1)
Coronary stenosis	
None	3 (10.7)
One vessel	2 (7.1)
Two vessel	5 (17.8)
Three vessel	18 (64.2)
Types of surgery	
CABG	25(89.3)
CABG/valvular	3 (10.7)

of cardiac arrest detected in postoperative days among 28 patients. Twenty eight reports mentioned capnography. In seven reports the capnography waveform and end-tidal value was normal even though the patient was pulse less, suggesting that normal pulmonary blood flow may continue in the presence of extremely low systemic arterial pressure.

DISCUSSION

The traditional guidelines for diagnosis are to assess the conscious state, and then check the Airway, Breathing, and Circulation (ABC).[29–31] The diagnosis of cardiac arrest in association with cardiac anesthesia is problematic for two reasons. Firstly, there is a continuous range of

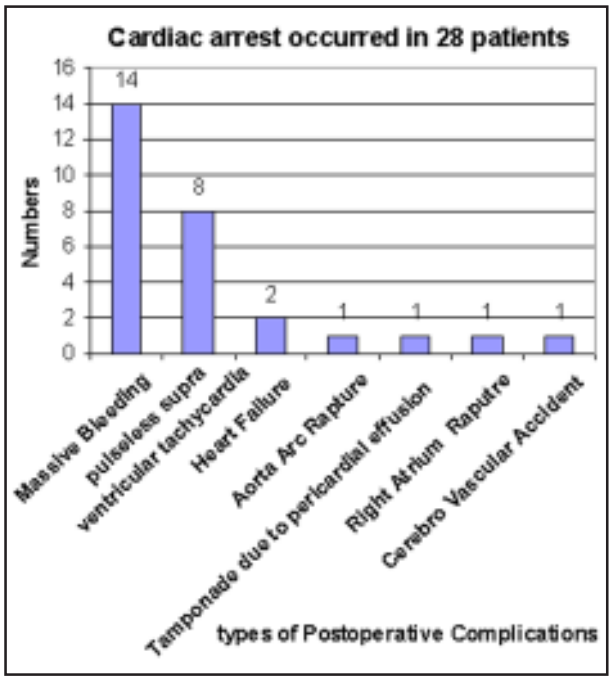

Fig-1: Reasons for cardiac arrest in 28 patients

reduction of cardiac output which makes it difficult to determine the point at which it becomes significant. In the few patients in this study who had intra-arterial pressure monitoring in place at the time of cardiac arrest, the impression was gained that, because a pressure trace was visible on the monitor, the anesthetist was less inclined to manage the patient as a cardiac arrest. Secondly, an arbitrary decision has to be made about what constitutes a significant duration of arrest. For example,

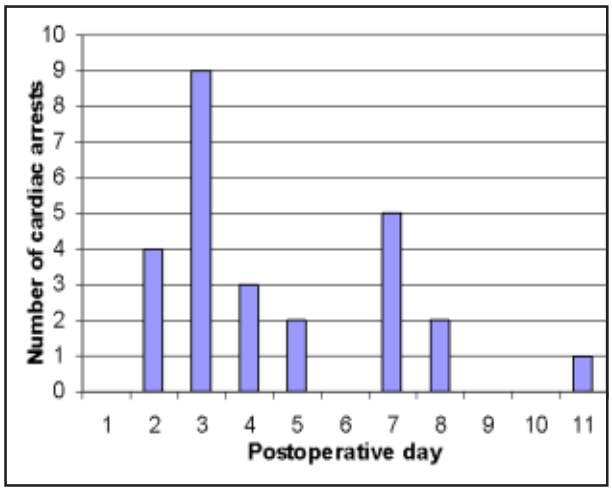

Fig-2: Numbers of cardiac arrest detected in postoperative days among 28 patients

should a vagal arrest of 30 seconds with prompt recovery be counted? The diagnosis should be made at the C stage of COVER, although other factors (listed below) often precede or accompany pulselessness.

Cardiac arrest may not be suspected if the oximeter signal is poor, if the ECG looks normal, or if the arterial pressure trace is present but the pressure is low. In these situations the circulation may be dangerously inadequate and delay in diagnosis may occur. The patient's pulse should be felt in all these situations and the oximeter probe should be removed from the patient and the oximeter function confirmed by placing it on one's own finger. Once cardiac arrest is detected, because there are often multiple aetiological factors a complete systematic assessment of the patient, equipment, and drugs should be completed even if a cause has already thought to have been found.

Perhaps anaesthetists are concerned by the hazards of treatment, especially during surgery in progress. Administration of 100% oxygen leads to awareness in some cases although, clearly, oxygen should be administered in an inspired concentration of 100% in all cases of cardiac arrest. Knowledge of appropriate oxygen circuits and their use is still insufficient. Adrenaline easily causes hypertension, myocardial ischaemia, and pulmonary oedema. Many of the patients given adrenaline received intermittent intravenous injections with consequent cardiovascular instability when an infusion would have been more appropriate. The preparation of an adrenaline infusion is an appropriate task for delegation. Cardiac compression may result in trauma to the heart, lungs, or chest wall with life threatening pneumothorax but, clearly, should not be delayed if indicated. The risk of continuing with surgery after ECC or defibrillation needs careful consideration.

The diagnosis and management of cardiac arrest in association with cardiac anesthesia differs significantly from that encountered elsewhere. Cardiac anesthetists in training should be specifically instructed and practicing anesthetists should regularly attend refresher course in diagnosis and management of cardiac arrest in association with cardiac anesthesia. The differences from non-anesthetic cardiac arrest should be emphasized. The diagnosis is made earlier and with greater precision; standard therapeutic modalities are used less frequently and to a lesser degree; and measures directed at alleviation of specific anesthetic and surgical causes are often possible. The outcome is generally good with the majority of patients leaving hospital alive and apparently well.

REFERENCES

1. Sprung J, Warner ME, Contreras MG. Predictors of survival following cardiac arrest in patients undergoing noncardiac surgery: a study of 518,294 patients at a tertiary referral center. Anesthesiology 2003;99:259-69.
2. Newland MC, Ellis SJ, Lydiatt CA. Anesthetic-related cardiac arrest and its mortality: a report covering 72,959 anesthetics over 10 years from a US teaching hospital. Anesthesiology 2002;97:108–15.
3. Morray JP, Geiduschek JM, Ramamoorthy C. Anesthesia-related cardiac arrest in children: initial findings of the Pediatric Perioperative Cardiac Arrest (POCA) Registry. Anesthesiology 2000;93:6-14.
4. Kawashima Y, Takahashi S, Suzuki M. Anesthesia-related mortality and morbidity over a 5-year period in 2,363,038 patients in Japan. Acta Anaesthesiol Scand 2003;47:809-17.
5. Biboulet P, Aubas P, Dubourdieu J. Fatal and non fatal cardiac arrestsrelated to anesthesia. Can J Anaesth 2001;48:326-32.
6. Imai Y, Mammoto T, Murakami K. The effects of preanesthetic oral clonidine on total requirement of propofol for general anesthesia. J Clin Anesth. 1998;10:660-65.
7. Taittonen M, Kirvela O. Cardiovascular and metabolic responses to clonidine and midazolam premedication. Eur J Anaesth 1997;14:190-196.
8. Pires LA, Wagshal AB, Lancey R. Arrhythmias and conduction disturbances after coronary artery bypass surgery: Epidemiology, management, and prognosis. Am Heart J 1986;129:799-808.
9. Dixon E, Genton E, Vack JL. Factors predisposing to supraventricular tachyarrhythmias after coronary artery bypass grafting. Am J Cardiol 1986;58:476-78.
10. Kowey PR. Atrial arrhythmias after cardiac surgery: Sisyphus revisited? J Am Coll Cardiol 1999;34:348-50.
11. Cagli K, G¨ ol K, Keles T. Risk factors associated with development of atrial fibrillation early after coronary bypass grafting. Am J Cardiol 2000; 85:1259-61
12. Deliargyris EN, Raymond RJ, Guzzo JA. Preoperative factors predisposing to early postoperative atrial fibrillation after isolated coronary artery bypass grafting. Am J Cardiol 2000; 85:763-64.

13. Kron IL, DiMarco JP, Harman PK. Unanticipated postoperative ventricular tachyarrhythmias. Ann Thorac Surg 1984;38:317-22.
14. Chiolero R, Borgeat A, Fisher A. Postoperative arrhythmias and risk factors after open heart surgery. J Cardiovasc Surg 1991;39:81-4.
15. Tam SKC, Miller JM, Edmunds LH. Unexpected sustained ventricular tachyarrhythmias after cardiac operations. J Cardiovasc Surg 1991;102:883-89.
16. Costeas XP, Schoenfeld MH. Usefulness of electrophysiologic studies for now-onset sustained tachyarrhythmias shortly after coronary artery bypass grafting. Am J Cardiol 1993;72:1291-4.
17. Natale A, Sra J, Axtell K. Ventricular fibrillation and polymorphic ventricular tachycardia after coronary artery bypass grafting. J Cardiovasc Electrophysiol 1994;5:988-94.
18. Azar RR, Berns E, Seecharran B. De novo monomorphic and polymorphic ventricular tachycardia following coronary artery bypass grafting. Am J Cardiol 1997;80:76-8.
19. Bigger JT, Whang W, Rottman JN. Mechanisms of death in the CABG trial. A randomized trial of implantable cardiac defibrillator prophylaxis in patients at risk of death after coronary artery bypass graft surgery. Circulation 1999;99:1416-21
20. Despotis GJ, Filos KS, Zoys TN, Hogue CW Jr, Spitznagel E, Lappas DG. Factors associated with excessive postoperative blood loss and hemostatic transfusion requirements: a multivariate analysis in cardiac surgical patients. Anesth Analg 1996;82:13-21.
21. Moulton MJ, Creswell LL, Mackey ME, Cox JL, Rosenbloom M. Reexploration for bleeding is a risk factor for adverse outcomes after cardiac operations. J Thorac Cardiovasc Surg 1996;111:1037– 46.
22. The Principal Investigators of CASS and their Associates. The National Heart, Lung, and Blood Institute Coronary Artery Surgery Study (CASS). Circulation 1981;63(suppl I):I-1–I-39.
23. Berens ES, Kouchoukos NT, Murphy SF, Wareing TH. Preoperative carotid artery screening in elderly patients undergoing cardiac surgery. J Vasc Surg 1992;15:313-23.
24. Wareing TH, Da´vila-Roma´n VG, Daily BB, Murphy SF, Schechtman KB, Barzilai B, Kouchoukos NT. Strategy for the reduction of stroke incidence in cardiac surgical patients. *Ann Thorac Surg.* 1993;55:1400-08.
25. Da´vila-Roma´n VG, Barzilai B, Wareing TH, Murphy SF, Kouchoukos NT. Intraoperative ultrasonographic evaluation of the ascending aorta in 100 consecutive patients undergoing cardiac surgery. *Circulation* 1991;84(suppl III):III-47–III-53.
26. Kouchoukos NT, Wareing TH, Daily BB, Murphy SF. Management of the severely atherosclerotic aorta during cardiac operations. J Card Surg 1994;9:490-94.
27. Da´vila-Roma´n VG, Phillips KJ, Daily BB, Da´vila RM, Kouchoukos NT, Barzilai B. Intraoperative transesophageal echocardiography and epiaortic ultrasound for assessment of atherosclerosis of the thoracic aorta. J Am Coll Cardiol 1996;28:942-7.
28. Da´vila-Roma´n VG, Barzilai B, Wareing TH, Murphy SF, Schechtman KB, Kouchoukos NT. Atherosclerosis of the ascending aorta: prevalence and role as an independent predictor of cerebrovascular events in cardiac patients. Stroke 1994;25:2010-16.
29. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Part III: Adult advanced cardiac life support.1992 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). JAMA 1992;268:2199-241.
30. The Advanced Life Support Committee of the Australian Resuscitation Council. Adult advanced life support algorithm, July 2002. Available at http://www.resus.org.au (accessed 12 September 2006).
31. The Advanced Life Support Committee of the Australian Resuscitation Council. Paediatric advanced life support algorithm, March 2004. Available at http://www.resus.org.au (accessed 12 September 2006).

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