Patterns of perioperative arrhythmias in adult cardiac surgery: A single center study from Sri Lanka

DVT Harischandra[1], JMRG Jayaweera[2], KANS Kannangoda, GVA Dilanka[2], KBP Hettigoda[1], S Amarasinghe[1]RK Firmin[4]

[1]Teaching Hospital Karapitiya, Galle, [2]Colombo NorthTeaching Hospital, [3]University Hospitals of Leicester, UK

Correspondence : *Dr DVT Harischandra; tolushah@gmail.com*
ORCID ID : *https://orcid.org/0000-0001-9791-5431*
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Abstract

Introduction

There is no published data on perioperative arrhythmias in adults undergoing cardiac surgery in Sri Lanka. The objective of this study was to assess the patterns of perioperative arrhythmias in cardiac surgical patients.

Methods and material

This is a prospective descriptive study of 100 patients in a single cardiothoracic unit in a tertiary care hospital in Sri Lanka from November 2018 to May 2020. Demographic data and clinical data were assessed in all patients. Furthermore, 24-hour Mobile Cardiac Outpatient Telemetry (MCOT) was assessed in a subset of patients.

Results

There were 72 males and 28 females. The mean age was 60 (range 37-76) years. The majority (76) had undergone isolated coronary artery bypass grafting (CABG). The mortality was 3.5% in routine and 15% in urgent/and emergency operations.

Arrhythmias were lowest preoperatively (11%). Arial fibrillation (AF) (6%) and sinus bradycardia (4%) were the commonest arrhythmias seen preoperatively. Arrhythmias were higher during surgery (29%) and ventricular fibrillation (VF) (25%) was the commonest. Arrhythmias were highest postoperatively (34%) and AF (12%) was the commonest followed by sinus tachycardia (9%). The higher incidence of arrhythmias in the in-hospital postoperative period as compared to the preoperative period was significant (p=0.0001).

A limited in-depth study using a mobile cardiac telemetry (MCOT) device showed a higher incidence of AF preoperatively (11%) and postoperatively (16%) but these differences were not significant when compared with that of routine investigations (p= 0.18 and p=0.35 respectively). However, the MCOT detected some arrhythmias completely missed by routine ECG recordings, notably supraventricular tachycardia, both pre operatively (22 %) and post operatively (33%).

Conclusions

This study has established baseline values of perioperative arrhythmias in the adult cardiac surgical patients in Sri Lanka. The MCOT methodology shows the potential for a more detailed study of arrhythmias and could inform decision-making in arrhythmia prophylaxis.

Key words : *Arrhythmia, cardiac surgery, Sri Lanka, atrial fibrillation*

Introduction

Cardiac arrhythmia is a leading cause of morbidity in cardiovascular disease and is potentially life threatening. Arrhythmias are common in cardiothoracic surgical patients, who by definition, have structural and functional problems of the heart. Furthermore, arrhythmias are a common complication during and after cardiac surgery [1,2]. Prophylaxis and timely recognition and treatment of perioperative arrhythmias are important both for the survival of the cardiac surgical patient and for the reduction of post-operative morbidity and hospital costs.

The world literature shows that as many as 30 -50% of post cardiac surgical patients can develop cardiac arrhythmias of which atrial fibrillation (AF) is the commonest pattern [1,3]. In Sri Lanka, there are no published data on perioperative arrhythmias.

Our objective was to assess the pattern of perioperative arrhythmias in cardiac surgical patients within a single unit in Sri Lanka.

Methods and material

This is a prospective descriptive study in a single cardiothoracic unit in a tertiary hospital in Sri Lanka from November 2018 to May 2020. Permission to do the study was obtained from the local ethical review committee and the hospital director. One hundred consecutive patients admitted for cardiac surgery were included over the study period and were followed through from the pre- to post-operative period. The exclusion criteria were patients who were already wearing pacemakers and implanted automatic defibrillators. In this series neither of these categories were, in any case, present. The minimum sample size was calculated using the Cochrane formula (4) and this was 48.

Informed consent was taken from the patients using a patient's information leaflet and consent form specifically designed for the study. Demographic data, clinical data with arrhythmia conditions and events during the study were collected using specially designed data extraction forms. In addition to the routine clinical assessment and investigations, 24 hour Mobile Cardiac Outpatient Telemetry (MCOT) was used in a subset of patients. This study was a means of collecting data for the algorithms that underpin their analysis. These were studied in depth. All data were entered prospectively on to an EXCEL spread sheet. The means, proportions and other relevant descriptive statistics were calculated.

Results

Over an eighteen month period, one hundred patients were recruited. There were 72 males and 28 females. The mean age was 60 (range 37-76) years. The majority (76) underwent isolated coronary artery bypass grafting (CABG) (Table 1). Eighty (80) were routine operations of which three died (3.5%) The remaining 20 were urgent/ emergencies, also of which three died (15%).

Operation	Number
Coronary Artery Bypass Grafts (CABG)	76
Mitral valve replacement (MVR)	7
MV repair	1
MVR + PFO Closure	1
MVR+CABG	1
Aortic valve replacement (AVR)	4
AVR + CABG	6
AVR+MVR	1
MVR+ AVR+ TV repair	1
Aortic root replacement +AVR+CABG	1
Atrial septal defect closure	1
Total	**100**

Table 1 : Type of operations

(TV -Tricuspid valve; MV -Mitral valve; PFO (Patent foramen ovale)

The majority (89%) of patients awaiting cardiac surgery showed no arrhythmias on routine investigations. Of the 11% of arrhythmias seen preoperatively, AF (6%) and beta blocker-induced sinus bradycardia (4%) were the commonest. The other ECG phenomena reflected underlying hypertrophy or ischaemia (Table 2).

Category	Arrhythmia	Number	Percentage
	No arrhythmias	**89**	**89%**
Fibrillation	Atrial fibrillation	6 (54.5%)	
Brady arrhythmias	Sinus bradycardia	4 (36.4%)	
Heart blocks	Right bundle branch block	1 (9.1%)	
	Total arrhythmias	**11**	**11%**
	Other ECG abnormalities		
	No abnormalities	66	66%
	T inversion	24(70.6%)	
	Flat T waves	2(5.9%)	
	ST elevations	1(2.9%)	
	ST depressions	2(5.9%)	
	LVH	3(8.8%)	
	Slurred S waves	1(2.9%)	
	Q waves	1(2.9%)	
	Total+	**34**	**34%**

Table 2 : Pre-operative ECG abnormalities (LVH -Left ventricular hypertrophy)

Arrhythmias were not apparent in 71 % of the patients during surgery. Of the 29 % of patients who had arrhythmias, ventricular fibrillation (VF) was the commonest. This frequently occurred post-ischaemic reperfusion and during rewarming on cardiopulmonary bypass (CPB), which is not unexpected (Table 3). There were a total of 32 types of arrhythmias in 29 patients, (i.e there were more than one type of arrhythmia in some patients)

Category	Arrhythmias	Number of arrhythmias	Percentage of arrhythmias
	No arrhythmias	71	71%
Fibrillation	Atrial fibrillation	3(9.4%)	
	Ventricular fibrillation	8(25%)	
Bradyarrhythmias	Sinus bradycardia	7(21.9%)	
	Nodal rhythm	1(3.1%)	
Tachyarrhythmias	Sinus tachycardia	5(15.6%)	
	Supraventricular tachycardia	2(6.3%)	
	Ventricular tachycardia	4(12.5%)	
Heart block	Complete heart block	1(3.1%)	
Heart block	Occasional Ectopics	1(3.1%)	
	Total arrhythmias	**32**	**32%**

Table 3 : Intra-operative ECG abnormalities

The intraoperative management of arrhythmias are as shown in Table 4. Due to the nature of the intervention with an open chest, bradycardias not responding to atropine were managed with single or dual chamber temporary epicardial pacing.

Intra operative management of arrhythmias	**Number**	**Percentage**
IABP	10	31.3%
Atropine	7	21.9%
Intra operative defibrillation	6	18.8%
Spontaneous resolution	5	15.6%
Atrial pacing	2	6.3%
Ventricular pacing	1	3.1%
DC cardioversion	1	3.1%
Total	**32**	**100%**

Table 4 : Intra-operative treatment (IABP-Intra-aortic balloon pump; DC – direct current).

Category	**Arrhythmia**	**Number**	**Percentage**
	No arrhythmias	71	71%
Fibrillation	Atrial fibrillation	12(35.3%)	
Bradyarrhythmias	Sinus bradycardia	3(8.8%)	
Tachyarrhythmias	Sinus tachycardia	9(26.5%)	
	Atrial flutter	1(2.9%)	
	Ventricular tachycardia	2(5.9%)	
Heart blocks	Right bundle branch block	1(2.9%)	
	Complete heart block	1(2.9%)	
Extrasystoles	Atrial ectopics	1(2.9%)	
	Ventricular ectopics	4(11.8%)	
	Total arrhythmias	**34(100%)**	**34%**
	Other ECG abnormalities		
	No other ECG abnormalities	66	66%
	T inversion	29(85.2%)	
	J point elevations	1(2.9%)	
	ST elevations	2(5.9%)	
	ST depressions	1(2.9%)	
	Flat T waves	1(2.9%)	
	Total of other ECG Abnormalities	34(100%)	34%

Table 5 : Post-operative ECG abnormalities

There was a higher incidence of arrhythmias in the in-hospital postoperative period (34%) as compared to the preoperative period (11%) that was statistically significant (p=0.0001). Some patients had more than one type of arrhythmia. AF was the commonest arrhythmia (12%) followed by sinus tachycardia (9%) post-operatively (Table 5).

There were no sudden deaths due to arrhythmias in this series.

A limited in-depth study on a random subset of patients was performed during this study using a mobile cardiac telemetry (MCOT) device over 24 hours. This showed a higher incidence of AF (11%) as opposed to the 6% seen on the standard ECG during the preoperative period (p= 0.18) and 16% as opposed to the 12 % (p=0.35) in the postoperative period. Neither were statistically significant.

However, the MCOT detected other arrhythmias that were missed by routine ECG recordings, notably supraventricular tachycardia, occurring both pre operatively (22%) and post operatively (33%) (Tables 6).

Abnormal Rhythms	Pre-operative	Pre-operative
Atrial Fibrillation	11.1%	16.7%
Supraventricular Ectopics	22.2%	33.3%
Ventricular Ectopics	7.41%	-
Pause & block	70.4%	50%

Table 6 : Mobile Cardiac Outpatient Telemetry (MCOT) data (pre-op N=27, post-op N=6)

Discussion

In our cardiothoracic unit, it had been our impression that about one third of our patients had rhythm problems, of which the commonest was atrial fibrillation. It had also been our impression that the commonest cause of sudden in-hospital death in our postoperative patients was a ventricular arrhythmia. None of these ideas had been formally studied.

The clinical significance of each arrhythmia depends upon its duration, ventricular response rate, underlying cardiac function, and comorbidities [1]. With the increased availability of electrophysiology expertise, advanced drug treatment/prophylaxis, pacing and automated defibrillation devices, we have become better equipped at managing these patients and preventing arrhythmic death. Thus, it is vital to understand the baseline information such that informed changes in practice may follow.

Clinically, the presence of arrhythmias is suspected when the history reveals symptoms such as palpitations, syncope or dizziness and examination reveals signs of abnormalities of the pulse rate and rhythm. A 12-lead electrocardiogram (ECG) with a rhythm strip is the first line of investigation to elucidate the type of arrhythmia. However, the ECG in this situation may be normal as the event is often self-limiting. This is why a method of continuous monitoring for a longer duration is important for proper assessment of arrhythmias. Today, Holter monitoring (HM) is usually the next step of investigating the patient with suspected arrhythmias to obtain a more comprehensive assessment and plan management. A HM will continuously record the patient's ECG, usually over a period of 24 –48 hours during which the patient is ambulatory. The continuous record thus obtained is reviewed by an electrophysiologist to determine the abnormality. Another form of ambulatory monitoring is the Cardiac Event Monitoring (CEM) where the patient can initiate a recording when experiencing symptoms. This, however, has the disadvantage that if the arrhythmia occurs without the patient noticing it, it fails to initiate the recording, and will be missed.

Mobile Cardiac Outpatient Telemetry (MCOT) is a relatively new technology to enter the world of Ambulatory Cardiac Monitoring. This technology is significant as it is a real-time ECG monitor that has the capability to automatically detect any ECG abnormality and automatically transmit this ECG information via cell phone technology to an accredited diagnostic laboratory for professional review. Unlike a Cardiac Event Monitor which detects ONLY symptoms felt by the patient, the MCOT monitor has the capability of transmitting both symptoms felt by the patient as well as abnormalities that are not felt by the patient.

This study was the ideal opportunity to gather ECG and clinical data for further improvement of the already developed computer algorithms for a locally produced MCOT device. This device contains an artificial neural network to detect algorithms. The data obtained from this study was used to train this artificial neural network in order to improve its accuracy. Therefore, this study provided a unique opportunity for the further development of a locally designed technology with the local collaboration of both medical and engineering expertise.

Arrhythmia management includes correction of correctable predisposing factors, as well as specific therapy for the arrhythmia itself. The urgency and the type of treatment required are determined by the clinical presentation of the arrhythmia. Self-terminating arrhythmias, in the setting of a transient stress, often need no therapy at all. However, the development of hemodynamically significant arrhythmias need a therapy for restoring a stable clinical status.

This is the first time that perioperative arrhythmias in the cardiac surgical setting in Sri Lanka has been formally studied. This study shows that the incidence of post-operative arrhythmias was at the lower end of the published range of 30 -50 %. This may reflect the frequent use of beta blockers (Bisoprolol or Metoprolol) as a unit policy in the majority of post-operative patients: those with asthmatic tendencies were instead given a calcium channel blocker (diltiazem). These policies constitute a prophylactic regime against post-operative hypertension, as well as atrial and ventricular arrhythmias.

The study also confirmed our clinical impression that atrial fibrillation was indeed the commonest cause of arrhythmia at 6% preoperatively, doubling its incidence in the postoperative period to 12%. AF is managed in our unit usually by amiodarone infusions, followed by an oral regime which is tailed off over a few months and sometimes with metoprolol or digoxin depending on the type of patient being treated. In the long term, anticoagulation and a rate/ rhythm control strategy is continued.

In this series, all intraortic balloon pumps (IABP) were inserted intraoperatively in the case of hypotension during discontinuation of CPB (Table 4). However, as has been shown in studies [5], IABPs also stabilize most ventricular arrhythmias and this was evident in our series as well. Intraoperative sinus bradycardia was managed with atropine and if not responding, by temporary atrial pacing. Intraoperative defibrillation was used in the case of ventricular fibrillation (VF) and ventricular tachycardia, followed by Magnesium sulphate, Lignocaine and Amiodarone infusions for the more intractable patients. None of the patients in this series needed permanent pacemakers.

The small number studied with the MCOT devise is a shortcoming of this study and may be a reason why the increased detection of AF was not statistically significant. Yet the MCOT detected arrhythmias that were not detected at all by routine ECGs. Comparing outcomes in a larger cohort of patients may identify high risk subgroups that could be treated more pro-actively. The data herein is insufficient for any conclusions to be drawn in this regard but shows the feasibility of this approach. Furthermore, the details shown within the traces that were performed show the potential for a more detailed understanding of the development of potentially fatal arrhythmias. If this is shown to be correct, then more aggressive proactive interventions in selected patients, with either drugs or devices, may improve outcome.

Conclusions

This study has established baseline values of perioperative arrhythmias in the adult cardiac surgical setting in Sri Lanka.

The current policy of using beta blockers and calcium channel blockers (when beta blockers are contraindicated) to reduce the incidence of common arrhythmias, such as atrial fibrillation, is supported using this data.

The 24-hour MCOT methodology that was tested herein shows the potential for the in-depth study of arrhythmia pathogenesis that could be used to more intensively treat the subsets of patients most at risk from sudden death.

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References

1. Giovanni Peretto, Alessandro Durante, Luca Rosario Limite, Domenico Cianflone Postoperative Arrhythmias after Cardiac Surgery: Incidence, Risk Factors, and Therapeutic Management Cardiology Research and Practice Volume 2014, Article ID 615987, 15 pages, Hindawi Publishing Corporation, https://doi.org/10.1155/2014/615987PMid:24511410 PMCid:PMC3912619

2. Hein J. J. Wellens HJ, Cardiac Arrhythmias: The Quest for a Cure A Historical Perspective , Journal of the American College of Cardiology Vol. 44, No. 6, 2004:1155-63 ISSN 0735-1097/04 Published by Elsevier Inc. https://doi.org/10.1016/j.jacc.2004.05.080PMid:15364313

3. Majd AlGhatrif, Joseph Lindsay, A brief review: history to understand fundamentals of electrocardiography, Journal of Community Hospital Internal Medicine Perspectives 2012, 2: 14383 -https://doi.org/10.3402/jchimp.v2i1.14383PMid:23882360 PMCid:PMC3714093

4. Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons

5. Goyal D, Nadar SK, Wrigley B, Koganti S, Banerjee P. Successful use of intra-aortic counter pulsation therapy for intractable ventricular arrhythmia in patient with severe left ventricular dysfunction and normal coronary arteries. Cardiology journal. 2010;17(4):401-3.