ORIGINAL ARTICLE

An Audit of Intraoperative Cardiac Arrests in a Tertiary Hospital in South East Nigeria

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ABSTRACT **Background:** Intraoperative cardiac arrest (IOCA) is a complication of surgery associated with a great risk of mortality. This study evaluated the incidence, risk factors, causes and outcomes of IOCA at a tertiary hospital in South East Nigeria.

Aim: It was a retrospective evaluation of the incidence, risk factors, causes and outcomes of intraoperative cardiac arrests at a tertiary hospital in South East Nigeria.

Patients and Method: A retrospective study of intraoperative cardiac arrests occurring over a 5-year period was conducted. Data on patient demographics, surgery, and complications were retrieved from patients' medical records and analyzed using the Statistical Package and Service Solutions (SPSS) version 25. Chi-square test analysis was used to determine relationship between risk factors and outcome. P-value of less than 0.05 was considered significant.

Results: The incidence of IOCA was 2.96 per 1000 with a mortality of 1.1 per 1000. There were 8 males were 5 females Majority of the cardiac arrests occurred during emergency surgery (69.2%) and within the first 120 minutes of surgery. Blood loss (53.9%) and hypertension (30.8%) were the commonest causes of IOCA. Majority of the patients (61.5%) had successful resuscitation and patients aged 21 – 40 years had better survival (50%) compared to other age groups.

Conclusion: The incidence of IOCA in this study is comparable with reports from other studies. Blood loss and intraoperative hypertension were the most common causes of IOCA. There was no significant relationship between risk factors and outcome of the intraoperative cardiac arrest.

Keywords: Intraoperative, Cardiac arrest, Audit, Risk Factors.

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INTRODUCTION

Intraoperative cardiac arrest (IOCA) is defined as intraoperative loss of detectable pulse requiring cardiac compression and/or defibrillation.[1] It is a rare often lethal complication of noncardiac surgery, with a reported immediate survival of about 50%.[2,3] This event although rare, is associated with high mortality. The risk of cardiac arrest and death during anaesthesia is not well understood.[4] Despite the increase in the volume of surgeries performed globally, scholars have reported the incidence of IOCA to be low and decreasing.[2,5] In Low and Middle Income Countries (LMIC), the volume of surgeries has been reported to be low at 877 surgeries per 100,000 population.[6] In Nigeria, some workers have reported the rate of cardiac arrest during anaesthesia to be 25.5 per 10,000 in Ibadan and 6 per 1000 in Lagos.[7,8] Other studies have reported the incidence rate to range from 1.1 per 10,000 anesthesia to 34.6 per 10,000 anaesthesia with a survival of 35% to 46.6%.[9-14]

Factors related to IOCAs include the physical status of the patient, surgical procedure, urgency of surgery and factors related to anaesthesia, cardiac anomalies, blood loss, severe hypotension, hypoxia, acidosis, electrolyte disturbance, nerve reflex, drug usage.[8-11] These factors are usually observed prior to occurrence of cardiac arrests. The presence of trained anaesthetists and monitoring ensures prompt recognition of cardiac arrests and commencement of resuscitation.

Intraoperative cardiac arrest is an important indicator of perioperative morbidity and mortality.[5] Because IOCAs are associated with poor outcomes, it is important to keep records of events and monitor the rate of occurrence in institutions.

This study conducted a retrospective evaluation to determine the incidence of IOCA, risk factors and causes of IOCA and its outcome at the Nnamdi Azikiwe University Teaching Hospital.

METHODOLOGY

Ethical approval for the study was obtained from the Nnamdi Azikiwe University Teaching Hospital (NAUTH) Ethics Review Board. The theatre records of non-obstetric patients who had surgery between 2018 and 2022 were retrospectively reviewed. Data included patients who had elective and emergency surgery. All cases of IOCA were analyzed to determine the incidence of IOCA, the immediate resuscitation rate, the factors leading to IOCA, and the risk factors of unsuccessful resuscitation in patients undergoing elective and emergency surgeries. Cardiac arrest was considered as any patient under anaesthesia with asystole or ventricular fibrillation requiring chest compression or electrical defibrillation, and recovery from cardiac arrest was considered to be sustained return of spontaneous circulation following a cardiac arrest.

Data collected included patient characteristics, age, gender, number of cardiac arrests, type of surgery, surgical procedure (elective or emergency), duration of surgery, complications, immediate cause of cardiac arrest and outcome of resuscitation.

The data collected was entered into an excel spreadsheet and reviewed to ensure accuracy and completeness. Statistical analysis was performed using the Statistical Package and Service Solutions (SPSS) version 25. For normally distributed quantitative variables, descriptive statistics was presented as mean ± standard deviation. In the case of non-normally distributed quantitative variables, descriptive statistics was presented as median and interquartile ranges. Categorical variables like intraoperative cardiac arrests were reported as frequencies and percentages. Chi-square test analysis was used to determine relationship between risk factors and outcome of the intraoperative cardiac arrest among patients. Statistical significance was set at a two-tailed p-value of less than 0.05.

RESULTS

A total of 4386 non-obstetric surgical procedures including both elective and emergency surgeries were performed. There was a total of 13 cardiac arrests and an overall incidence of 2.96 per 1000. There were 8 males (61.5%) and 5 females (38.5%) and more than half of the patients were between ages 21-40 years (53.8%) while 30.8% were between ages 1-20 years. (Table 1)

The IOCA resulted in 5 mortalities (38.5%), a mortality of 1.1 per 1000. (Table 2) Females had higher mortality (60%) among the patients that died, and survival was higher among the males (75%). In this study, patients who had emergency surgery, neurosurgical and general surgery procedures, large volumes of blood loss and hypertension were more at risk of having IOCA. Also, IOCA was more likely to occur within the first 120 minutes of surgery and in patients who received ketamine/midazolam combination at induction of anaesthesia. (Table 3) There was no significant relationship between risk factors and outcome of the intraoperative cardiac arrest, p>0.0. (Table 3)

Table 3 shows that majority of the cardiac arrests occurred during emergency surgery (69.2%). Neurosurgery and general surgery were the specialties with the highest number of cardiac arrests at 46.1% and 38.5% respectively. Majority of the cardiac arrests (69.2%) occurred within 120 minutes of commencement of surgery. Common risk factors recorded among the patients that suffered cardiac arrests were large volumes of blood loss (53.9%), intraoperative hypertension (30.8%), intraoperative hypotension (7.7%), and hypoxia (7.7%). General anaesthesia was induced using ketamine + midazolam combination and propofol in majority of the cardiac arrest patients 46.1% and 30.8% respectively.

Majority of cardiac arrest was caused by blood loss (53.9%) and hypertension (30.8%). (Table 3) Resuscitation was successful in majority of the patients (61.5%). (Table 2) Patients aged 21 to 40 years had better survival (50%) compared to other ages. (Table 5)

Table I: Descriptive analysis of age and gender

Variables	Frequency (n=13)	Percentage (%)
Age (years)		
1-20	4	30.8
21-40	7	53.8
61-80	1	7.7
81 and above	1	7.7
Mean±SD	29.9±24.7	1.5 – 85
Gender		
Female	5	38.5
Male	8	61.5
Total	13	100.0

n- number SD- Standard Deviation

Table III: Risk factors for intraoperative cardiac arrest e.g. type of surgery, surgical specialty, duration of surgery, complications, emergency or elective surgery.

Variables	Frequency (n=13)	Percentage (%)
Type of surgery		
Elective	4	30.8
Emergency	9	69.2
Surgical specialty		
ENT	1	7.7
General Surgery	5	38.5
Neurosurgery	6	46.1
OBS & Gynaecology	1	7.7
Duration of surgery (minutes)		
1-120	9	69.2
121-240	1	7.7
241-360	1	7.7
361 and above	2	15.4
Complications		
Blood Loss	5	38.4
Hypertension	4	30.8
Hypotension	1	7.7
Hypoxia	1	7.7
Massive Blood Loss	2	15.4
Surgery		
Craniotomy + tumor excision	1	7.7
Craniotomy+ Microsurgical Tumor Excision	1	7.7
Craniotomy+ Tumor Excision	2	15.4
Exploratory laparotomy	2	15.4
Foreign body removal	1	7.7
Frontoparieto temporo occipital craniotomy	1	7.7
PMCRTA with compound commuted depressed Right. temporal skull fracture	1	7.7
Anesthetic agents		
Ketamine	2	15.4
Ketamine + Midazolam	6	46.1
Propofol	4	30.8
Propofol + Ketamine	1	7.7
Total	13	100.0

n- number
ENT- Ear, Nose and Throat
PMCRTA- Pedestrian Motorcycle Road Traffic Accident

Table II: Outcome of the intraoperative cardiac arrest

Variables	Frequency (n=13)	Percentage (%)
Outcome		
Death	5	38.5
Resuscitated	8	61.5
Total	13	100.0

n- number

Table IV: Causes of intraoperative cardiac arrests

Variables	Frequency (n=13)	Percentage (%)
Immediate cause of arrest		
Asphyxia	1	7.7
Blood Loss	7	53.9
Hypertension	4	30.8
Hypotension	1	7.7
Total	13	100.0

n- number

DISCUSSION

In this study, the overall incidence of IOCA is 2.96 per 1000. This finding is similar to figures reported by Rukewe et al[7] in Ibadan, which reported an incidence of 25.5 per 10,000. Like our study, Rukewe et al[7] analyzed data retrospectively over a 5-year period from 2005 to 2010. Their study was however conducted in a larger center and had a larger volume of surgical procedures numbering 12,143 cases unlike ours which had 4,386 cases. Rukewe et al[7] reported a mortality rate of 11.5 per 10,000 is comparable to our mortality rate of 1.1 per 1000. Like our study, Rukewe et al[7] conducted a retrospective study and obtained data from patients' hospital records including anaesthetic charts. However, unlike our study, they also included 24-hour post operative follow up in the intensive care unit. Despite the influence of the inclusion of post operative period in their study, the incidence of IOCA and mortality rate are are comparable with our findings. This is possibly due to our patient population being similar to theirs. In their study, they considered cardiac arrest as occurring in any patient under anaesthesia with asystole or ventricular fibrillation requiring chest compression or electrical defibrillation. However, while they considered recovery to be an alive, non-comatose patient 24 hours after cardiac arrest, our study considered recovery to be sustained return of spontaneous circulation following a cardiac arrest.

The incidence of IOCA in our study differs from what has been reported by Desalu and Kushimo[8] who recorded an incidence of 6 per 1000 in Lagos. Unlike our study which covered a period of 5 years, the study by Desalu and Kushimo[8] covered a period of 1 year. Similar to our study, Desalu and Kushimo[8] included data from both elective and emergency surgeries, but also included follow up cases that extended up to the discharge period, unlike our study. This period of follow up may have

played a role in the higher incidence reported by the researchers.

Table V: Relationship between risk factors and outcome of the intraoperative cardiac arrest

Variables	Outcome		X^2-value	p-value
	Death (n=5)	Resuscitated (n=8)		
Age (years)				
1-20	2 (40.0)	2 (25.0)		
21-40	3 (60.0)	4 (50.0)	1.532	0.675
61-80	0 (0.0)	1 (12.5)		
81 and above	0 (0.0)	1 (12.5)		
Gender				
Female	3 (60.0)	2 (25.0)	1.592	0.207
Male	2 (40.0)	6 (75.0)		
Anesthetic agents				
Ketamine	0 (0.0)	2 (25.0)		
Ketamine + Midazolam	2 (40.0)	4 (50.0)	4.198	0.241
Propofol	3 (60.0)	1 (12.5)		
Propofol + Ketamine	0 (0.0)	1 (12.5)		
Type of surgery				
Elective	3 (60.0)	1 (12.5)	3.259	0.071
Emergency	2 (40.0)	7 (87.5)		
Surgical specialty				
ENT	1 (20.0)	0 (0.0)		
General Surgery	0 (0.0)	5 (62.5)	6.662	0.083
Neurosurgery	3 (60.0)	3 (37.5)		
Gynaecology	1 (20.0)	0 (0.0)		
Duration of surgery (minutes)				
1-120	2 (40.0)	7 (87.5)		
121-240	1 (20.0)	0 (0.0)	6.428	0.093
241-360	0 (0.0)	1 (12.5)		
361 and above	2 (40.0)	0 (0.0)		
Complications				
Blood Loss	2 (40.0)	3 (37.5)		
Hypertension	0 (0.0)	4 (50.0)		
Hypotension	0 (0.0)	2 (12.5)	7.930	0.094
Hypoxia	1 (20.0)	0 (0.0)		
Massive Blood Loss	2 (40.0)	0 (0.0)		
Immediate cause of arrest				
Asphyxia	1 (20.0)	0 (0.0)		
Blood Loss	2 (40.0)	3 (37.5)		
Blood Loss/Hypertension	2 (40.0)	0 (0.0)	7.930	0.094
Hypertension	0 (0.0)	4 (50.0)		
Hypotension	0 (0.0)	1 (12.5)		

n- number ENT- Ear, Nose and Throat

This incidence of IOCA in our study is higher than what was reported by Jian-Xiong et al[14] who reported an incidence of 1.05 per 10,000 anaesthetics and a mortality rate of 1.0 per 15,625 anaesthetics. Unlike our study which included both paediatric and adult age groups, Jiang-xiong et al[14] reported the incidence of IOCAs in only adult patients. This may be responsible for their lower incidence compared to ours.

Other workers have reported incidence of IOCAs involving the paediatric age group, Zuercher and Ummenhofer[15] showed that incidence of cardiac arrests was greater in paediatric patients at 1.2-4.6 per 10,000 anaesthetics. These figures surpass the findings from our centre. Possibly because they focused on the paediatric age group, which may be at higher risk of anaesthetic complications because of the peculiarities associated with the paediatric age group such as airway management challenges. Hur et al[16] reported 50 cases of IOCA out of 238,648 adult surgical patients, with an incidence of 21/100,000. Of these, they recorded 19 intraoperative fatalities giving a 38% intraoperative mortality, comparably, with an incidence similar to ours, they also had an intraoperative mortality rate similar to ours which stands at 38.5%. Unlike our study which was done over a 5-year period, Hur et al[16] collected data

spanning a period of 10 years, hence, their larger volume of surgeries. Hur et al[16] noted surgical emergencies, non-shockable initial cardiac rhythms, pre-operative complications, surgical complications, long duration of chest compressions, high total epinephrine dose, transfusion and continuous infusion of inotropes or vasopressors in the ICU as risk factors for 3-month mortality after IOCA, our study found no significant relationship between risk factors and outcome of the intraoperative cardiac arrest ($p>0.05$). Unlike the report by HUR et al[16], our study did not follow up patients till the postoperative period. However, despite the period covered in our study, the lower incidence of IOCA reported by Hur et al may be because their work was conducted in an environment with different state of medical facilities.

All the cases of cardiac arrest in our study occurred within 120 minutes of induction with none occurring at induction of anaesthesia , similarly, Jian-xiong et al[14] reported that nearly all their cases of intraoperative cardiac arrests occurred during maintenance of anaesthesia. In their study, out of 23 patients that had cardiac arrests during surgery, 22 of them had their arrests occurring during maintenance of anaesthesia, while one arrest occurred at induction of anaesthesia. No possible reason was proffered for this occurrence, however, it is possible that risk factors of cardiac arrests may be more likely to occur during maintenance of anaesthesia. Han et al[2] also corroborated our findings concerning time of onset of cardiac arrest. While not suggesting a possible reason, they reported that no cardiac arrest occurred at induction, with all IOCAs happening during maintenance of anaesthesia. However, unlike our study, in which all the cardiac arrest cases had general anaesthesia, in the study by Han et al[2], 13 out of the 15 patients (86.7%) received epidural anaesthesia either alone or in combination with general anaesthesia. Han et al[2] did not establish any relationship between anaesthetic technique and the occurrence of cardiac arrests. Similar to our study, intraoperative hemorrhage was a common cause of IOCA (33.3%) in the study by Han et al[2]. This may occur when the rate of blood loss overwhelms its replacement. This may be more devastating in very ill patients.

In our study, neurosurgery and general surgery accounted for the highest number of cardiac arrests at 46.1% and 38.5% respectively. These surgical procedures tend to be associated with large volumes of blood loss, which may result in cardiac arrests. Comparably, Constant et al[1], reported that 57.1% of IOCAs occurred in emergency surgeries, but in contrast, abdominal surgery (26.4%), thoracic surgery (20.7%) and vascular surgery (12.9%) accounted for the most common surgeries associated with IOCA. Other workers identified cardiothoracic surgery, neurosurgery, major gynaecological and abdominal surgeries as being associated with IOCAs.[7,8] These differences may be accounted for by the possible differences in the types of surgical cases that tend to present to facilities in these environments.

Some studies have attributed IOCA to preoperative complications, anaesthetic complications and the surgical procedure.[1,17] Eagle et al[17] also noted that it was both the type of surgery and the degree of hemodynamic stress associated with the procedure that constitute the risk to patients.

In our study, majority of the IOCAs occurred during emergency surgery (69.2%), however, no significant difference in frequency of arrests was found between elective and emergency surgery ($p = 0.071$). Similarly, Rukewe et al[7] found no difference in the frequency of arrests between elective and emergency surgeries. In their study, among the fatal arrests, most of the patients (71.4%) had elective surgery, while a lower number (28.6%) had emergency surgery, but in the non-fatal arrests, 64.7% were emergent surgeries while 35.3% were electives. Similarly, in our study, majority of the fatal arrests (60%) had elective surgery, while the reverse was the case in the non-fatal arrests where 87.5% had emergency surgery. (Table 5). There may be factors responsible for this finding, such as the ASA physical status of the patients and blood loss. Our study environment is similar to that of Rukewe et al and could account for the similarities of our findings.

Risk factors of IOCA identified in our study include blood loss, hypertension, hypotension, asphyxia. This differs from findings by Desalu and Kushimo[8] which showed hypoxaemia, hypovolemia and increased intra-abdominal pressure from pneumo-peritoneum were identified causes.Other workers have shown intraoperative hemorrhage, end-stage organ disease and thromboembolic events to be leading causes of cardiac arrests in the operating theatre.[14] It is therefore important that emphasis should be placed on the reduction and control of these factors in both prevention of IOCA and improvement of the success of resuscitation.

All patients in our study received standard monitoring during anaesthesia. This may be contributory to prompt detection of arrests, thereby enhancing the success of resuscitation. Studies have shown that monitoring accounts for decreases in the rate of anaesthetic cardiac arrests from respiratory causes.[3,15,18] On the other hand, some authors have suggested that the evidence supporting the use of monitors of cardiac arrest is weak.[19] Braz et al[20] have suggested that IOCAs are associated with higher incidence of survival due to availability of monitoring, airway and intravenous access and trained manpower in the operating theatre, thus reflecting the quality of surgical and anaesthesia care provided in theatre. In our center, anaesthesia is provided by a consultant physician anaesthetist led team, consisting of both physician anaesthetists of different levels of training and also nurse anaesthetists. It has been demonstrated that there is an inverse relationship between the incidence of cardiac arrests and the number of anaesthetists employed.[21]

LIMITATIONS

Because this was a retrospective study, it was not possible to analyze some factors such as the American Society of Anesthesiologists (ASA) physical status of patients, interval between onset of cardiac arrest and commencement of resuscitation and the use of defibrillation, due to unavailability of data.

CONCLUSION

The incidence of IOCA in patients undergoing elective and emergency surgery was 2.96 per 1000 with a mortality of 1.1 per 1000 between 2018 and 2022. No IOCA occurred at induction of anaesthesia, all occurred during maintenance of anaesthesia. Blood loss and intraoperative hypertension were the most common causes of IOCA. There was no significant relationship between risk factors and outcome of the intraoperative cardiac arrest.

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