EMERGENCY THORACIC SURGERY IN CHEST TRAUMA AT THE KOMFO ANOKYE TEACHING HOSPITAL IN GHANA: THE ROLE OF STERNOTOMY AND THORACOTOMY

Okyere I[1]; Singh S[2]; Ameyaw E[3]; Okyere P[4]; Yeboah FA[5]; Brenu SG[6]; Tamatey M[7]

[1]Department of Surgery, [2]Department of Anaesthesia and Intensive Care, [3]Department of Child Health, [4]Department of Internal Medicine, [5] Department of Molecular Medicine, School of Medicine and Dentistry, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana; [6] Directorate of Surgery, Komfo Anokye Teaching Hospital, Kumasi, Ghana; [7] Department of Surgery, School of Medical Sciences, University of Health and Allied Sciences, Ho, Ghana.

Abstract

Objective: Chest trauma, as blunt or penetrating injury, account for significant amount of all traumatic injuries. They are associated with high mortality of about 75% of all trauma-related deaths, either from direct or indirect consequence of the injury. Nearly 80-85 % of chest trauma is managed conservatively with only about 10-15 % needing emergency surgery

Methodology: A retrospective cohort study of patients presenting with chest trauma and undergoing emergency thoracic surgery at the Komfo Anokye Teaching Hospital from January 2015 to June 2020 was carried out.

Results: There were 29 patients, with 82.8% (24) being males. The mean age was 33.8 ± 15.0 years with range of 5-65 years. The leading mechanism of chest trauma was penetrating chest injury, which accounted for 51.7% (15). Eighteen (86%) patients underwent exploratory thoracotomy with 5 (10%) having exploratory sternotomy and the remaining 4% undergoing other procedures. Fourteen (82.1%) patients out of the eighteen who underwent the thoracotomy had a left thoracotomy with four (24.1%) patients having right thoracotomy. The major indication for surgery in acute thoracic trauma was traumatic diaphragmatic rupture (62.1%) followed by impalement injury (17.2%), traumatic thoracotomy (6.9%), cardiac tamponade (6.9%), massive haemothorax (3.5%), and vascular injury (3.5%). There were no mortality over the 5-year period.

Conclusion: The leading indication for emergency thoracic surgery in chest trauma was traumatic diaphragmatic rupture caused mostly by penetrating thoracic injury. Thoracotomy was the major emergency thoracic surgical approach performed.

Key words: *Chest trauma, thoracotomy, sternotomy, emergency surgery, Kumasi*

Introduction

Chest trauma, whether as blunt or penetrating injury, account for significant amount of all traumatic injuries. They are associated with high mortality of about 75% of all trauma-related deaths, either as direct or indirect consequence of the thoracic injury. However, nearly 80-85% of chest trauma is managed conservatively with only about 10-15% needing emergency surgery.

We sought to therefore analyse our institutional results of emergency thoracic surgery in chest trauma patients presenting to our accident and emergency centre. These patients underwent either thoracotomy or sternotomy at the Komfo Anokye Teaching Hospital in Kumasi, Ghana over a 5-year period. The purpose of the study was therefore to provide information that would guide practitioners and referring doctors of the possible roles of emergency surgery in chest trauma.

Corresponding Author: **Dr. Isaac Okyere**
Department of Surgery, School of Medicine and Dentistry, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
Email Address: isaac.okyere@knust.edu.gh
Conflict of Interest: None Declared

Materials and Methods

Patients Selection

A retrospective cohort study carried out at the Cardiovascular and Thoracic Surgery Unit of the Directorate of Surgery at the Komfo Anokye Teaching Hospital involving all patients who underwent either thoracotomy or sternotomy for chest trauma from January 2015 to June 2020. The data were obtained from the theatre records of the patients. The data included the sociodemographics, the mechanism of injury, the type of thoracic surgery, the type of anaesthesia and complications. The analyses for means, frequencies, and standard deviations were performed using Microsoft excel 2010 statistics software and Stata 13.

Study setting

The study site is the cardiovascular and thoracic surgery unit of the department of surgery of the Komfo Anokye Teaching Hospital which was established in 2015.The unit comprises of three subspecialties of surgery as a composite; vascular surgery, adult and paediatric cardiac surgery and

Thoracic Surgery. It currently has one cardiovascular and thoracic surgeon and a thoracic surgeon. It runs two clinics per week and operates twice a week handling all vascular, cardiac and thoracic surgery services. It also runs a daily cardiovascular and thoracic emergency surgery services. The unit has an intensive care unit, one theatre, a pharmacy and one general ward.

Komfo Anokye Teaching Hospital in Kumasi is the second-largest hospital in Ghana and the only tertiary health institution in the middle belt of the country. It is the main referral hospital for the Ashanti, Bono, Bono East, Ahafo, Northern, Savannah, North East, Upper East and Upper West regions of the country. The hospital was built in 1954 and affiliated to the School of Medicine and Dentistry of the Kwame Nkrumah University of Science and Technology, Kumasi-Ghana.

Ethical Approval

The ethical approval for this study was granted by the Committee on Human Research, Publications and Ethics of the Komfo Anokye Teaching Hospital with approval number KATHIRB/AP/097/20.

Results

There were 29 patients, with 82.8% (24) being males and 17.2% (5) being females. The mean age was 33.8 ± 15.0 years with range of 5-65 years. The leading mechanism of chest trauma was penetrating chest injury, which accounted for 51.7% (15), with blunt chest trauma accounting for the remaining 48.3% (14). Eighteen (86%) patients underwent exploratory thoracotomy with 5 (10%) having exploratory sternotomy and the remaining 4% undergoing other procedures. Fourteen (82.1%) patients out of the eighteen who underwent the thoracotomy had a left thoracotomy with four (24.1%) patients having right thoracotomy. Fifteen (82.8%) patients had conventional anaesthesia with five (17.2%) having double-lumen anaesthesia for single lung intubation and isolation. The major indication for emergency thoracic surgery in acute thoracic trauma was traumatic diaphragmatic rupture (62.1%) followed by impalement injury (17.2%), traumatic thoracotomy (6.9%), cardiac tamponade (6.9%), massive haemothorax (3.5%), and vascular injury (3.5%). The leading intrathoracic organ herniation for the traumatic diaphragmatic rupture was the stomach with the greater omentum. There were no mortality over the 5-year period.

Discussion

Thoracic or chest trauma or injuries, be it blunt or penetrating, account for significant amount of all traumatic injuries.[1–3] They are associated with high mortality; about 75% of all trauma-related deaths from either direct or indirect consequences of the injury.[4] A third of all victims of road traffic accidents sustain some form of thoracic injury.[5]

Despite its high incidence, majority of the injuries are managed non-operatively with simple but life-saving procedures such as chest tube insertion or tube thoracostomy.[3,4] Figures as high as 85% have been quoted as being the proportion of thoracic trauma injuries managed conservatively.[6] Moreover, it is also noted that surgical or operative management is less in blunt chest injuries as compared to penetrating injuries with rates of 10% and 30% being quoted respectively. These surgical thoracic trauma injuries usually involve injuries to the heart and great vessels, the lungs and the intercostal vessels.[2,5] Consistent with the reports above, we observed a higher incidence of surgical intervention in patients who presented with penetrating chest injuries, representing 51.7%.

Epidemiology of Chest Trauma

Thoracic trauma has been quoted to contribute about 10-15% of the total burden of traumatic injuries. [7] It has been reported to be the third most common traumatic injury after head and extremity traumas in the United States of America and second only to extremity trauma in Brazil. [7] As shown in **Table 1** and consistent with our findings, several studies have identified a male preponderance in chest trauma,[8–11] with 24 (82.8%) patients out of the 29 patients being males in our series. Even though the incidence of chest trauma as described by Thomas and colleagues from Nigeria was found to be particularly high among the young adult group [9], several studies have sought to elucidate its importance in the paediatric population.[12–14] The mean age of our series was 33.8 years, which was similar to the observation by Thomas et al in Nigeria.[9] We postulate that this similarity in incidence may be seen in most centres in Africa. The plausible explanation for this may be from the young age population of most African countries. Thoracic trauma in paediatric populations account for 10% of trauma cases with majority of the associated injuries being more visceral with less thoracic cage injuries [13]. This has been attributed to the increased chest wall pliability in children with reduced chances of rib fractures.[12,13] Our youngest patient was 5 years and he had a thoracic impalement injury from a pair of scissors to the left chest wall missing the pericardium by 2 mm while playing with a friend. He was referred from a whole day's journey from another part of the country with the scissors in situ thankfully. He was quickly prepared for exploratory thoracotomy upon arrival after aggressive resuscitation and stabilization and underwent successful removal in operating theatre via a left

standard posterolateral thoracotomy. He has been well since and is continuing his childhood endervours.

Table I: The Patients Demographics

Variable	Frequency = 29	Percentage
Age	**33.8 ± 15.0**	
Gender		
Female	5	17.2
Male	24	82.8
Occupation		
Trader	4	13.8
Student	4	13.8
Artisan	8	27.6
Farmer	8	27.6
Unemployed	5	17.2
Level of education		
Basic	15	51.7
None	3	10.3
Secondary	11	37.9
Marital status		
Married	12	41.4
Single	17	58.6

Aetio-Clinico-Pathogenesis of Chest Trauma

According to Zhang *et al,* thoracic trauma is classified based on organ involvement into chest wall, cardiovascular, pulmonary and oesophageal injuries.[15] A study by Khorsandi *et al* listed the spectrum of commonly encountered thoracic injuries to be rib fractures (36.3%), major haemothorax (36.3%), simple pneumothorax (32.9%), cardiac injuries (26%), lung lacerations (21.2%), pericardial lacerations (11.6%), coronary artery laceration (6.1%), cardiac tamponade (3.4%) and haemopericardium without tamponade (1.4%). [1] Thoracic trauma may also be classified based on mechanism of injury into blunt or penetrating thoracic injuries. Blunt chest traumas are generally more common than penetrating chest trauma. This was observed by Demirhan *et al.* who showed that 66% of the over 4000 patients recruited into their study had blunt chest injury. [11] A similar figure was quoted even among the paediatric population by Ceran *et al.* in 2002. An epidemiological study carried out in Brazil by Zanette and associates in 2019 quoted an even higher incidence of 89%,[7] similar to the 90% incidence reported by Ludwig and Koryllos. [16] In contrast to the above observations, we noticed a higher incidence of penetrating trauma in our series in patients with chest trauma needing emergency thoracic surgery accounting for 51.7%.

Blunt chest trauma has been reported to be most commonly caused by road traffic accidents in a number of series.[7,11,13,17,18] Other documented causes include falls from height, violence and occupational injuries.[11,18] Penetrating chest injury, on the other hand, often implicate stab and gunshot wounds as its main causes. Clarke *et al* in a study done in South Africa demonstrated that 90% out of 1186 patients with penetrating chest trauma were due to stab injuries with the remaining 10% being attributed to gunshot injuries. [8] In the paediatric population, a study done in Nigeria showed that falls were the most common cause of chest trauma, with majority of these falls being from trees of economic importance such as those with fruits and palm trees from which palm wine is obtained.[14]

Based on threat to life associated with the thoracic injury, chest injuries may be grouped into immediately life-threatening injuries known as 'the lethal six',(upper airway obstruction, tension pneumothorax, open pneumothorax , massive haemothorax, flail chest , and cardiac tamponade), the potentially life-threatening injuries termed 'the hidden six'(traumatic diaphragmatic rupture, traumatic esophageal rupture, tracheobronchial injuries, myocardial contusion, aortic injury and pulmonary injury) and the non-life threatening injuries (rib fracture, simple pneumothorax, simple haemothorax and thoracic wall contusion). [6,16,19]

Acute and Chronic Indications for Surgery in Chest Trauma

Despite the seemingly high numbers of traumatic chest injuries, surgical intervention is mandated in a small proportion of the patients. Clarke and colleagues, in their review on emergency surgery after penetrating chest trauma in South Africa demonstrated that surgery was employed in only 9% of the 1186 patients reviewed.[8] The indications for surgery in chest trauma can be grouped into immediate or acute indications, relatively immediate and then chronic or long-term indications.[18]

The most common indication for surgical intervention in a retrospective study done in Turkey in 2009 was found to be intra-thoracic haemorrhage [11]. Haemothorax is deemed massive and an absolute indication for surgery if there is an initial drain output of 1500mls (or 15mls/kg) or there is an hourly output of 200mls/hour (2-3mls/kg/hour) for 3-4 consecutive hours. [6,19] However, our series observed that the leading indication for emergency thoracic surgery was traumatic diaphragmatic rupture, which was responsible for 62.1% of the cases. This was followed by impalement injury (17.2%), massive haemothorax (3.5%), traumatic thoracotomy (6.9%), cardiac tamponade (6.9%) and vascular injury (3.5%). The leading intrathoracic organ herniation for the traumatic diaphragmatic rupture was the stomach with the greater omentum. We postulate that the leading indication for thoracic surgery in chest

trauma from diaphragmatic rupture may be due to the presence of a cardiothoracic surgeon, establishing a new cardiovascular and thoracic surgery unit in the hospital Moreover, the cardiothoracic surgeon is usually the one who is called first by the emergency physicians at the emergency and accident centre of our hospital in most cases of chest trauma with suspected traumatic diaphragmatic rupture or injury, especially in cases with associated pleural collections such as haemothorax, pneumothorax or haemopneumothorax or in cases with minimal signs of peritonism. As expected, the cardiothoracic surgeon usually prefers to approach the repair of traumatic diaphragmatic rupture via thoracotomy and therefore this may be the plausible explanation to the finding of traumatic diaphragmatic rupture being the leading indication for emergency thoracic surgery in our series.

The Surgical Approaches to Emergency Surgery in Chest Trauma

In a study by Beşir *et al* which was carried out to assess the surgical approach in managing cases of penetrating cardiac injuries, majority of the patients were managed via thoracotomy with similar report from Mollberg *et al.*[20,21] The surgical approach utilized was made based on the site of injury and the possibility of lung involvement.

Pulmonary, posterior cardiac and oesophageal injuries in that study were mainly approached via thoracotomy due to ease of access while cardiac injuries, especially anterior mediastinal injuries and injuries to the great vessels were best approached via median sternotomy.[20] The trajectory of the injury, the location of the injured organ and the ease of access are factors that influence the choice of surgical approach.[4] A prospective study done in 2002 showed that 14% of 543 patients who had sustained penetrating chest injuries from stab wounds required thoracotomy or sternotomy.[22] Consistent with the reports above and as shown in **Figure 3,** we also observed that the major surgical approach in our series was thoracotomy forming about 86% with sternotomy forming 10%. Eighty-two percent of the thoracotomies were through left thoracotomy with majority being done for traumatic diaphragmatic rupture. Two of the patients sustained open thoracotomy chest injuries with chest wall disruption and had to undergo chest wall reconstruction. One patient had a blast right chest injury with extensive chest wall tissue loss leading to lung herniation from the blast of a gunshot. The other had open thoracotomy injury from a compound harvester farm machine leading to avulsion injury of the left hemithorax with near amputation of the left breast and open abdominal injury with evisceration of small intestines. They all underwent successful surgery and reconstruction of the chest wall primarily.

Three patients had traumatic right diaphragmatic rupture and had to be repaired through right standard posterolateral thoracotomy. They all had herniation of the liver as shown in **Figure 2.** Emergency department thoracotomy (EDT) is a drastic procedure done in the emergency room in patients in extremis mostly after penetrating chest injuries and less often in blunt chest injuries. [4] The main aims of performing an EDT are for effective cardiac compression, control of haemorrhage, evacuation of pleural or cardiac tamponade, cross clamping of the pulmonary hilum in bronchopleural fistula or air embolism and cross-clamping of descending aorta to control lower torso bleeding or shunt blood to the brain and the heart..[3–5] Emergency room thoracotomy is indicated in cases of cardiac arrest in spite of resuscitation. However, its usefulness has been debated in multiple studies as it has been associated with poor outcomes especially in blunt chest injuries. [3] A review of multiple studies by Khorsandi *et al* reported abysmal survival rates ranging between 0-6% [1]. Another study also showed survival rates of 8.8% and 1.4% for penetrating and blunt chest injuries respectively [5]

However, a systematic review of all European articles on EDT in blunt chest trauma by Narvestad *et al* reported a significantly higher rate of 12.6%. Our centre as yet has no experience with Bedside thoracotomy despite our accident and emergency centre being a trauma centre with operating theatre suites and therefore offering the potential for early resuscitation and stabilization leading to early surgical intervention.

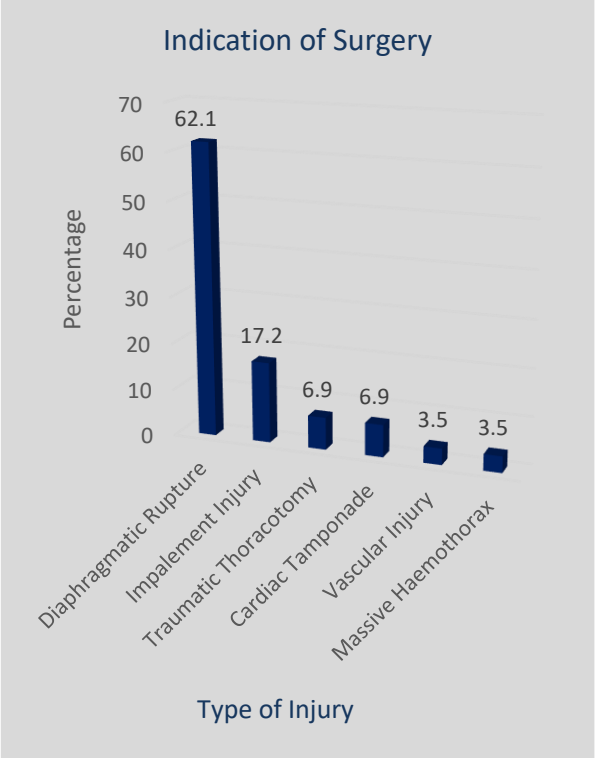

Figure 1: The distribution of Indication of Surgery

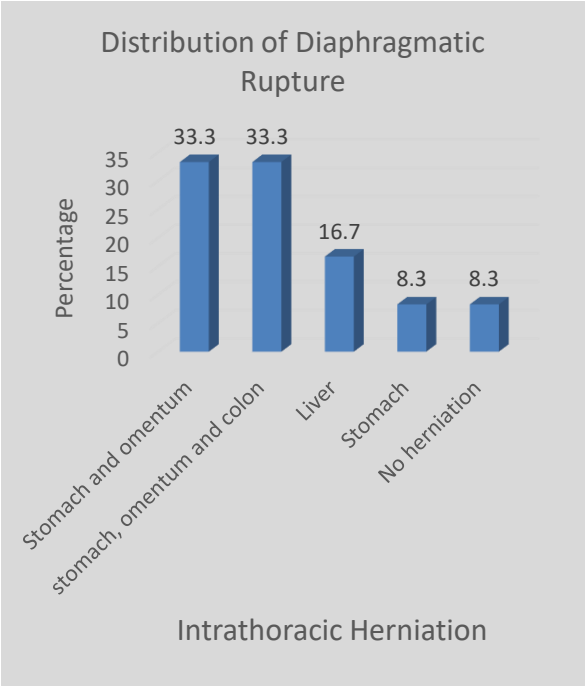

Figure 2: Distribution of Intrathoracic Organ Herniation in Diaphragmatic Rupture

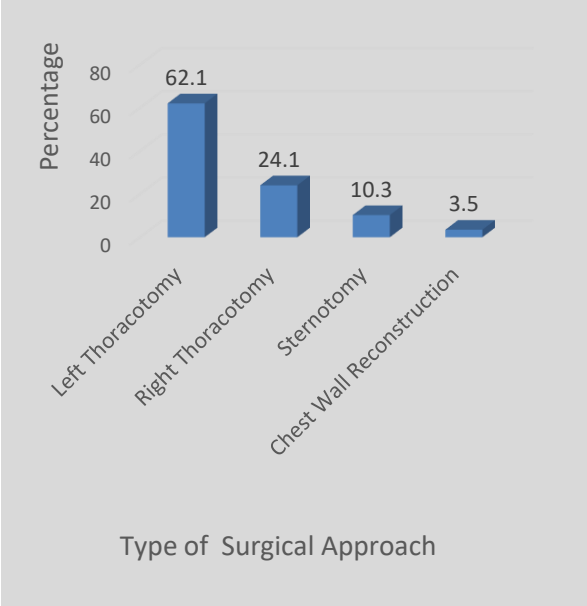

Figure 3: Distribution of Surgical Approach

The Role of Sternotomy and Thoracotomy in Chest Trauma

Thoracotomy in the management of acute thoracic injuries can be done immediately in the emergency room on arrival as indicated above as EDT, in the operating theatre within 1-4 hours on arrival or delayed for conservative management until a surgical indication arises. [4,23] It has been reported to be the most popular approach to operative management in traumatic thoracic injuries. Almost consistent with our series as noted from **Figure 3,** that thoracotomy represented 86.2 % of our thoracic emergency surgery with median sternotomy forming only 10.3%, Mollberg *et al* reported that out of 222 patients who required surgical management on account of thoracic trauma, 57.2% of them were approached via thoracotomy while 18.9% had a median sternotomy done. Its popularity may stem from the fact that it offers access to more organs in the thorax as compared to a median sternotomy.[20,24] However, Clarke *et al.* demonstrated a marginal popularity of sternotomy over thoracotomy in their study. Of the 108 patients who required surgical intervention, 56 out of them (51.8%) were approached via sternotomy while the rest of them had thoracotomy.[8]

Though thoracotomy is indicated in the management of cardiac tamponade and repair of some cardiac injuries, median sternotomy has been advocated because of its ability to provide better exposure of the heart and great vessels as well as ease of cannulation in the event of the need for cardiopulmonary bypass.[24] Despite its relative difficulty, need for experienced hands and associated risk of developing sternal sepsis, median sternotomy is the best approach for gaining access to the anterior mediastinum in emergency settings.[8] Median sternotomy provides optimum exposure in most cases of parasternal stab injuries since the damage is mostly limited to the anterior mediastinum. Moreover, right parasternal gunshot injuries are best approach via median sternotomy. However, due to the difficulty in repairing the posterior wall of the left ventricle if injured, left parasternal gunshot injuries are best explored via a left posterolateral thoracotomy.[4]

Conclusion

The leading indication for emergency thoracic surgery in chest trauma was traumatic diaphragmatic rupture caused mostly by penetrating thoracic injury. Thoracotomy was the major emergency surgical approach performed.

Limitations of the Study

Our study had a small sample size with limited data.

What is already know on this topic

The rate of indication of emergency surgery is low as most chest trauma patients are managed conservatively. There is higher rate of emergency surgery in penetrating chest trauma patients as compared with blunt chest trauma. The commonest indication for emergency surgery in chest trauma is massive haemothorax.

What this study adds

There is a younger age range of patients with chest trauma The commonest indication for emergency surgery in chest trauma is diaphragmatic rupture followed by impalement injury.

Authors' contributions

Isaac Okyere conceived the idea, did data collection and analysis and wrote the manuscript including the literature review. Sanjeev Singh did a critical review of the manuscript. Perditer Okyere did a review of the literature and provided critical revision to the manuscript. Emmanuel Ameyaw contributed to the literature review and manuscript drafting. Samuel Gyasi Brenu provided critical revision to the manuscript. Martin Tamatey did a critical review of the manuscript. Francis Agyemang Yeboah also provided critical revision of the final manuscript. All authors read and approved the final copy of the manuscript.

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