

**AFRICAN JOURNAL OF
MEDICINE
and medical sciences**

VOLUME 30, NUMBER 4, DECEMBER 2001



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**ASSISTANT EDITOR:
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ISSN 1116 — 4077

Penetrating chest injuries in civilian practice

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Summary

The purpose of this retrospective study is to show the pattern of penetrating chest injury, methods of management and the outcome. We reviewed all consecutive penetrating chest injured patients admitted to the Cardiothoracic Surgical Unit of the University College Hospital, Ibadan between May 1975 and April 1999. We found that 597 patients had penetrating chest injuries. This was 31% of all chest injuries treated. To analyse pattern of injuries, period of study was divided into 2 periods of 12 years each, May 1975 to April 1987 (Group A) and May 1987 to April 1999 (Group B). Mean ages of the patients in group A and B were, respectively, 27 ± 12.5 years and 48 ± 10.2 years; male:female ratio for the 2 groups were 20:1 and 17:1, respectively. The main mechanisms of injury were gunshot wounds (GSW) in 364 patients (61%) and stab wounds (SW) in 214 patients (35.8%). The ratio of GSW to SW was reversed for the 2 periods, 1:3 for group A and 7:1 for group B. Nine patients died during resuscitation. Four hundred and eleven patients of 588 patients (69.9%) were managed conservatively. Sixty-five (11.1%) by clinical observation and 346 (58.8%) by closed thoracostomy drainage. Mortality among the conservatively managed was 2.2%, morbidity was 18.2% (75 out of 411 patients). Ninety patients had early major surgery, 75 had late major surgical management of complication of conservative management. The operative mortality was 22% (in 39 patients). The determinant of mortality were haemorrhage, respiratory insufficiency and sepsis. We conclude that penetrating injury is a third of chest injuries we see. It is commoner in men and currently involves the older age group and it is most frequently inflicted by gunshot. Majority may be managed conservatively with low incidence of complications. Prompt major surgery limits mortality among the salvageable.

Keywords: *Penetrating, chest injuries, civilian practice*

Résumé

Le but de cette étude retrospective était de montrer un exemple d'une blessure de poitrine pénétrant, les méthodes d'en s'occuper et le résultat. On avait fait une revue de tous les malades avec une blessure de poitrine pénétrant admis au service cardiothoracique chirurgical du collège hospitalier universitaire d'Ibadan entre le mois de mai 1975 et d'avril 1999. On avait découvert que 597 malades avaient des blessures de poitrine pénétrant. Cela reponds au 31% des blessures de poitrines soigné. Pour analyser les types des lésions, la duré d'étude était divisée en 2 périodes de 12 ans par période à savoir: de mai 1975 à avril 1987 (Groupe A) et de mai 1987 à avril 1999 (Groupe B). Les moyennes âges des malades en groupe A et B étaient $27 \pm 12,5$ ans et 48 ± 10.2 ans respectivement; la proportion homme: femme pour les 2 groupes étaient 20: et 17:1 Les causes principales de blessure étaient, blessure de balle (BDB) en 364 malades (61%) et blessure de poignard (BDP) en 214 malades (35,8%). La proportion BDB à BDP était renversée pour les 2 périodes, 1:2 pour le groupe A

et 7:1 pour le groupe B. Neuf, malades sont morts pendant la réanimation. Quatre-cent-onze malades entre les 588 malades (69,9%) ont été manié conventionnellement. Soixante-cinq (11,1%) à traver l'observation clinique et 346 (58,8%) par un drain thoracostomique clos. La mortalité parmi ceux qui ont été maniés conventionnellement était 2,2%, la morbidité était 18,2% (75 des 411 malades). Quatre-vingt dix-neuf malades avaient subi un chirurgie principale très tôt, 75 ont eu une chirurgie principale tardive de complication en provenance de traitements conventionnels. La mortalité operationelle était 22% (parmi 39 malades). L'hémorragie, l'insuffisance respiratoire et le sepsis étaient les déterminants de la mortalité. Nous concluons que la blessure pénétrant reponds à un tiers des blessures de poitrine. C'est plus fréquent chez les hommes et cela implique actuellement les hommes agés et c'est plus fréquemment causé par des coups de fusil. Dans plupart de cas, cela peut être manié conventionnellement avec un taux de complications baissées. La chirurgie principale fait très tôt réduit la mortalité parmi ceux qu'on peut sauver.

Introduction

Chest injuries are being seen with increasing frequency in urban hospitals [1]. However, hospital data, do not reflect the true spectrum and extent of the problem. This is partly accounted for by the fact that some of the injuries to the chest are instantly fatal. The outcome of a patient with penetrating chest injury also depends on the availability of first aid, the speed of evacuation from site of injury and the distance to the nearest meaningful emergency medical care [2,3]. Not all penetrating injuries of the chest require surgical operation [4]. The conservative management of such injuries has evolved mainly as a result of improved management and understanding of penetrating chest injuries [5,6]. Most of the penetrating injuries in civilian practice are usually secondary to low-velocity missiles or stab wound [7,8,9].

The purpose of this retrospective study is to show the pattern of penetrating chest injury, methods of management and the outcome in a cardiothoracic unit over a 24-year period.

Clinical materials and methods

We reviewed all consecutive penetrating chest trauma patients admitted to the cardiothoracic surgical unit of the University College Hospital, Ibadan, between May 1975 and April 1999.

The data reported here were accumulated from the following sources: the inventory of all the units admissions and treatments, review of the weekly units service activities, a review of the operative log books and postmortem records. No one source was complete. Duplicate entries were eliminated and differences adjudicated. Data extracted for analysis included demographics, mechanism of injury, type of injury, associated extrathoracic injury, methods of management and outcome.

Management at the emergency department of the University College Hospital, Ibadan, included the triage, the initial restoration of blood volume, creation and maintenance of patent airways and treatment of associated injuries. Multidisciplinary-based treatments are initiated by appropriate referrals.

The standard method of initial managements of chest trauma patients in our unit over this period remains uniform. After the initial resuscitative measures, decisions as to the necessity for intercostal tube placement without x-ray confirmation of hemo or pneumothorax depends on the clinical status of the patient. Patients were placed on clinical observation for 12-24 hours in the acute phase. Patients with clinical/radiologic evidence of hemo or hemopneumothorax following penetrating lung injury underwent intercostal tube thoracostomy, done as an emergency. Under local anaesthesia, a multifenestrated number 36 or 38 argyle chest tube or the drainage tube of *Aldon's Urobag was inserted through the fifth, six or seventh intercostal space within the mid-axillary line. The tube was directed posterior and superior, and secured with number one silk. The volume of blood retrieved on insertion was assessed and subsequently patients are followed carefully for evidence of continued hemorrhage, persistent air leakage and adequacy of intrathoracic fluid and air evacuation. All patients had additional X-ray for radiographic confirmation of tube placement, and were treated with intravenous antibiotics.

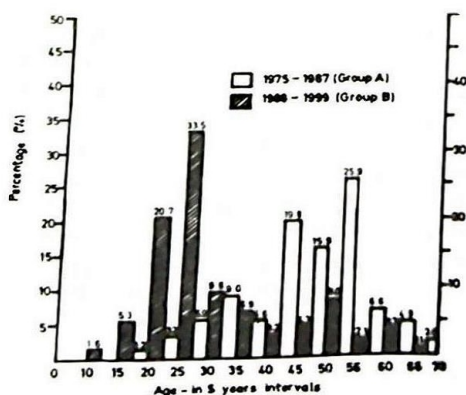
Results

Five hundred and ninety-seven patients with penetrating chest injuries were managed by the unit during the 24-year period. This constituted 31% of all chest injuries admitted and treated by the cardiothoracic unit during the period.

To simplify the analysis of the pattern, the period of study was divided into 2 periods of 12 years each, May 1975 – April 1987 (Group A) and May 1987 – April 1999 (Group B). During the period, 553 (92.6%) patients were transported by non-ambulance conveyances. This suggested minimal, uninformed or no first aid before arrival at the University College Hospital. The remaining 44 (7.4%) patients were transported by ambulances.

The ages of the patients in group A ranged between 12 and 66 years (mean 27 ± 12.5 years) and for group B ranged between 16 and 70 years (mean 48 ± 10.2 years). The frequency distribution of ages by percentage among patients with penetrating chest injuries is shown in the figure. The male:female ratio for the two groups, 20:1 and 17:1 for group A and B, respectively, was similar.

FIG FREQUENCY DISTRIBUTION OF AGE BY PERCENTAGE AMONG PATIENTS WITH PENETRATING CHEST INJURIES WHOSE AGES WERE KNOWN



There were, on the whole, 364 patients (61%) with gunshot wounds (GSW) and 214 patients (35.8%) with stab

wounds (SW). Other mechanisms of injury included, impalement injuries, explosives and animal attacks. However, the of the GSW to SW was reversed for the 2 periods, 1:3 for group A and 7:1 for group B. The mechanisms of injury are shown in Table 1. The injury by explosives was due to gas cylinder explosions in 2 welders and the third happened to a petrol attendant in a gas station. Horned animal attacks were the cause of penetrating injuries in 4 children and 2 adults.

Table 1: Mechanisms of injury in 597 penetrating wounds of the chest.

Mechanism	Group A 1975-1987	Group B 1987-1999
Stab wounds	134	80
Gunshot wounds	45	319
Impalement injuries	4	6
Explosives	-	3
Others		
Animal attacks	5	1

Nine patients died during resuscitation, the cause of death were thoracoabdominal injuries, haemorrhage and respiratory failure. Five hundred and eighty-eight patients were treated. The method of management included clinical observation of the chest status and various surgical procedures. (Table 2)

Table 2: Management of 588 patients with penetrating thoracic injuries

Mode of Management	Number of patients n (%)
Conservative	411 (69.9)
Observed	65 (11.1)
Closed thoracostomy tube drainage	346 (58.8)
Operative	177 (30.1)
Thoracotomy	138 (23.5)
Laparotomy	22 (3.7)
Laparotomy-Thoracotomy	7 (1.2)
Sternotomy	6 (1.0)
Others	
Trap-door incision	4 (0.7)

Eighty-one patients were initially managed by clinical observations. This mode of management was used because these patients were initially clinically stable. The causes of the chest injuries among these 81 patients were buck-shots, 55 patients (67.9%), stab wounds, 20 patients (24.7%), local lead bullet (Hausa version), 4 patients (4.9%) and high velocity bullet wound, 2 patients (2.5%). Nine of these (11.1%) had subcutaneous emphysema and 11 patients (13.5%) had associated extrathoracic trauma. Six of the latter subsequently required abdominal surgery and evacuation if clotted haemothorax. Ten other patients (8.1%) managed initially by clinical observation, subsequently developed hemo or haemopneumothorax significant enough for the institution of CTTD. On the whole, 65 of the 81 patients initially managed by clinical observation (11.1% of all 588 survivors) were treated by only clinical observation. There was a mortality of 9 (11.1%) among these 81 patients. In 6 pa-

tients it was related to the associated abdominal injuries, 2 patients died of massive pulmonary embolus and one patient died from haemoptysis secondary to infected parenchymal haematoma.

Six (1.2%) of the remaining 507 patients proceeded to major surgery without CTTD while 501 (85.2%) had initial CTTD. The total number of CTTD out of 588 patient was 511 (86.9%), this included the 10 patients who were initially managed by clinical observation. Ninety (18%) of these needed early major surgery. Three hundred and forty-six patients (58.8%) had CTTD as the definitive treatment (table 2). Seventy-five (15%) needed late major surgery for the management of complications of conservative management. The mortality among the conservatively managed group was 2.2% (9 out of 411 patients). Morbidity was 18.2% (75 out of 411 patients).

The thoracic indications for surgery and outcome are summarized in Table 3. The extrathoracic organs involved in association with penetrating chest injuries in 33 patients are summarized in Table 4. There were 29 thoracoabdominal injuries, constituting 4.9% of all managed penetrating chest injuries.

Table 3: Thoracic indications for surgery and outcome

Indications	Procedure	No. of Patients (n)	Deaths n (% within each group)
Immediate Resuscitative	T	2	2
Early (within 24 hours)			
Haemorrhage	T	55	14 (25.5)
Diaphragmatic injuries	L	16	7 (43.8)
Pracordial-Neck	ST/TD	10	4 (40.0)
Tracheobronchial injuries	T	2	0
(TBI)	TD/SI	2	0
TBI Oesophageal injury	T	2	0
Late (after 24 hours)			
Clotted haemothorax	T	38	0
Fibrothorax	T	21	0
Empyema	T	16	0

T = Thoracotomy, L = Laparotomy, Laparotomy followed by Thoracotomy, ST = Sternotomy, TD = Trapdax incisions
SI = Sternocleidomastoid incision for neck exploration.

Table 4: Extrathoracic organs involved in 33 patients with penetrating chest injuries

Organs	No. of patients
Liver	17
Spleen	12
Stomach	10
Small intestine	8
Colon	5
Kidney	4
Neck	2
Celiac Axis	2
Superior mesenteric artery/vein	4
Spine	4
Common iliac vessels	2
Axillary artery	2

These thoracoabdominal Injuries were 32.2% of 90 patients treated by emergency major operations and they determined

some of the operative approaches employed. The commonest extrathoracic organs involved were abdominal and included the liver, spleen and stomach.

The operative mortality was 22% (in 39 patients). The mortality occurred among patients who had immediate or early surgery and was highest (43.8%) among patients with thoracoabdominal injuries (Table 3).

The morbidities related to the major surgical interventions included wound infection (20 patients), atelectasis (12 patients), subphrenic abscess (11 patients), respiratory failure (5 patients) and hepato-renal failure (3 patients). The complications associated with penetrating chest injuries in this series are summarized in table 5. The commonest of these were atelectasis and haemorrhage but the determinants of mortality were haemorrhage, respiratory insufficiency and sepsis (Table 6).

Table 5: Complications of penetrating chest injuries

Complications	Number
Atelectasis	71
Haemorrhage	58
Recurrent pneumothorax	17
Respiratory insufficiency	24
Wound infections	20
Clotted Haemothorax	38
Empyema thracis	21
Fibrothorax	29
Subphrenic Abscess	11
Hepato-Renal failure	3

Table 6: Causes of 46* deaths in patients having penetrating chest injury

Causes of death	No.
Haemorrhagic/Hypovolemic shock	28
Respiratory insufficiency	24
Multiple organ failure	9
Sepsis/abscess	6

*Many of the patients had combinations of these causes

Discussion

Penetrating injuries of the chest are less common in our practice in comparison to blunt chest injuries throughout the entire period of study. Most penetrating chest wounds are secondary to social violence and are preventable [10]. This factor, among others, can determine and therefore alter the incidence of penetrating chest injuries over a period of time. In a large epidemiological survey [8], 90% of the patients sustained penetrating chest injuries, while similar reviews [10,11] presented blunt chest trauma as most dominant causes of chest injuries. The prevalence of type of chest injury depends on the interplay of the local socio-economic and geographical factors. Age, sexual distribution of certain mechanisms of injuries and catchments areas are other factors involved in the relative frequency and distribution of penetrating chest wounds [12,13]. In our study, the two twelve-year period each reflected periods of social violence. The group A violence occurred in the political violence era with extensive inter-party thuggery, involving the young, viable pro

portion of the Nigerian male population. The instruments of conflict were mainly sharp, pointed instrument. The group B violence were concurrent with increase in spate of armed robbery related to unemployment. The weapon of attack were mostly locally manufactured guns. The population at risk in the latter group were mainly persons with property hence the older members of the population.

The majority of the patients had unsupervised transportation. Rapid transportation and improved prehospital management of trauma victims contributes to the number of survivors who arrive at trauma centers [14,15,16]. That only 9 patients died during resuscitation suggests that majority died at scene of accidents or injury due to lack of coordinated regional/state/local government trauma services. Establishment of emergency medical services improves salvage rates and increases number of treated patients [8,15]. This factor also altered the severity of injuries we treated. The improvement in ambulance services will increase the number of survivors who will arrive at our hospitals and will alter the severity of the injuries we will treat.

Urgent needs of acutely injured patients are those of adequate ventilation, circulation and blood volume. Penetrating chest injuries may, in addition result in ventilatory failure from hypoventilation, secondary to massive air leakage or volume loss due to compression from tension pneumothorax or large haemothorax [5]. Circulatory failure may be caused by exsanguination or myocardial ischemia [2,6]. However, majority require either close observation with continuous monitoring of vital signs and serial chest radiographs or early tube thoracotomy, volume replacement and airway management [5,7,9]. The proportion of patients treated with this method in the literature ranged between 75.6% and 91% [1]. In our series the corresponding value of 70.9% accords well with this range. Our lower value may be partly responsible for increased morbidity in our series, which increased the indication for late thoracotomy. The overall mortality of the patients who had conservative management of their penetrating chest injury is 2.2%, which is within the range of 0.4% [7] and 2.3% [1]. Sited in the literature. While the mortality in our series following conservative management resulted from intraabdominal injuries, the reported causes of death listed in the literature among the conservatively managed were head injury, irreversible hypovolemic shock, pulmonary embolism and respiratory failure [1,5,6]. This finding stresses the importance of repeated evaluation among patients under conservative management for early detection of changes in clinical status.

Associated injuries and other co-morbidities are important risk factors for death among patients managed conservatively [5,7,17,18]. The aetiological factors involved in the complications attending the conservative methods have been well studied. Atelectasis has been associated with the pain of chest injury, prolonged intercostal tube drainage also causes pain which prevents deep breathing and coughing [19]. Empyema thoracis complicating re-inserted intercostals drainage tube and prolonged pleural drainage are consequent upon bacterial contamination, incomplete drainage of pleural space and the presence of a foreign body [19,20,21]. The presence of these factors have influenced the incidence and distribution of these complications in our series and others in the literature [20,21]. Early evacuation of clotted haemothorax has been our practice and this when done within the first 7 days is an easy procedure through a limited thoracotomy [21]. Delayed evacuation of haemothorax beyond 4-6 weeks following injury produces

fibrothorax, which requires a more difficult decortication [22]. In our experience, longer delay was attended by poor reexpansion of the lung.

The number of patients requiring thoracotomy varies, but in several large series [2,5,6,9], they constitute 15 to 25% of all patients with penetrating chest wounds. Our value of 23.5% accords well with this range. We practice minimum emergency room thoracotomy (ERT) but the criteria and indications for such have been well elucidated elsewhere [3,4,9]. The indications for thoracotomy in our study also conform to standard practice in the literature [9]

Penetrating wounds of the chest are often associated with intraabdominal injuries. The reported incidence of thoracoabdominal injuries varies from 10 to 30% with a mortality of 20 to 27% [7]. Our experience also agrees with the reported finding of increasing number of involved intraabdominal organs [7,23,24]. The management of thoracoabdominal injuries presents perplexing problems. Most authors now recommend approaching the abdomen first unless there is uncontrollable evidence that the patient is exsanguinating from aortic injury [18]. The immediate life threatening injury in patients who survived to the hospital are usually found in the abdomen [18]. This philosophy influenced our surgical approach in some of the thoracoabdominal injuries in this study. Most penetrating diaphragmatic injuries and associated intraabdominal injuries were thus diagnosed intraoperatively and managed.

With precordial penetrating wounds, we found it prudent to have emergency operation without clinical signs or expanding haematoma, as delay in operation accounted for the mortalities incurred. Emergency procedures have been found to be life saving [2,5,6].

We adopted conservative management if major bronchus involved was less than one, third of the circumference of the bronchus or was limited to a small defect in the membranous portion of the bronchus. This approach is in agreement with several large series [25,26]. A key indicator of successful conservative management possible is the ability to re-expand the involved lung and maintain the expansions with a single chest tube. We operated when respiratory distress occurred with suction to the pleural space or when positive ventilation was contemplated. These are standard indications for repair [2,6].

Our experience accords with the fact that penetrating injuries to the oesophagus may in majority of cases be associated with airway injuries [27,28]. Patients found to have thoracic tracheobronchial injury should be considered to be at risk for an associated oesophageal injury and should have barium swallow and oesophagoscopy [6]. This approach afforded early diagnosis and management of the 2 cases of oesophageal injury in this study with no morbidity nor mortality. A delay in diagnosis of thoracic oesophageal perforation beyond 24 hours carries a high mortality rate because a chemical mediastinitis is incited with progression to multiple organ failure [2,28].

Early, appropriate management of the pleural space drainage and maintenance of pulmonary parenchymal toileting would limit the overall complications in the salvageable patients with penetrating chest injury. Avoidance of sepsis enhances recovery and limitation of the development of multiple organ failure [7,20]

In summary, the majority of patients having penetrating chest injuries may be managed conservatively with low incidence of complication. Prompt major surgical procedures appropriate for abdominal and thoracic injuries when aggressively pursued limit mortality among the salvageable group.

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