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Research Paper

Diaphragmatic Injuries on The Plateau

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ABSTRACT
Background*: Diaphragmatic injuries are uncommon, and its management challenging as if missed can be lethal. This study evaluates our experience in the management of diaphragmatic injury in adult patients who presented to the Accident and Emergency Unit of a Teaching Hospital in Jos, Plateau state.*
Objective: *To determine the pattern, management modalities and treatment outcome of diaphragmatic injuries in Jos, Nigeria.*
Methods*: The medical records of patients admitted to our facility with diaphragmatic injury from January 2013 to December 2024 were reviewed retrospectively and analyzed.*
Results: *Fifty-five cases were analyzed from the period. M:F was 6.9:1, with mean age at presentation of 25.56±7.16. Commonest mechanism of injury was penetrating, and the left side was the most injured part. All the patients had laparotomy through midline approach. Stomach was also injured in 83.6% and 43.6% had infective complications. One patient developed diaphragmatic hernia. Mortality rate was 5.5%, which included the only missed injury.*
Conclusion: *Traumatic diaphragmatic injury commonly involve young adult males, and commonly from penetrating mechanism mainly from firearms. Left side is the side most affected, and stomach is the most other organ injured. Delayed presentation, missed injury, firearm injuries and central location are associated with higher mortality. Laparotomy remains an effective modality of treatment.*

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I. INTRODUCTION

Diaphragmatic injuries refer to trauma to the diaphragm, which can be blunt or penetrating in nature. Injury to the diaphragm is a relatively rear but serious trauma.[1, 2, 3] The diaphragm is a c-shaped structure of muscle and fibrous tissue that separates the thoracic cavity from the abdomen. [4]As such injuries to it can affect the respiratory and cardiovascular systems, as well as septic complications that can occur from gut involvement. The clinical presentation may include difficulty in breathing, chest pain and paradoxical respiration in flail chest, or with features acute shortage of blood. A few may not have any symptom at presentation and may be missed, presenting much later with hernia and its complications. [4] Being a relatively rare injury, a high index of suspicion is therefore required to detect the occult forms, as missed injuries are associated with higher morbidity and mortality. [4]

The commonest part of the diaphragm injured is the left side. [1] Injury to the central portion is associated with higher morbidityand mortality.[6]The management of diaphragmatic injuries like other serious injuries follows the Advance Trauma Life Support ATLS Protocol with resuscitation before definitive treatment. The operative treatment can be open or minimally invasive, both of which could be via the chest or abdomen. [8,9]

The aim of this study was to provide insight into the etiology, operative management and outcome, including mortality of diaphragmatic injury in Jos University Teaching Hospital.

Key words: Jos University Teaching Hospital, diaphragmatic injuries, significant trauma, laparotomy.

II. METHODOLOGY

This was a retrospective study of patients who presented with diaphragmatic injury to the Accident and Emergency unit of Jos University Teaching Hospital (JUTH), Jos, Nigeria. The medical records of the patients admitted and managed for diaphragmatic injury between January 2013 and December 2024 were retrieved from our Trauma Registry, and patients' folders, and subsequently analyzed.

Diagnosis of diaphragmatic injury was made based on the history of trauma, difficulty in breathing, chest pain, anemia, chest X-ray, focused assessment sonography for trauma (FAST), and intraoperative findings of diaphragmatic laceration.

The information extracted from the patients' medical records included age at presentation, sex, mechanism of injury, duration of injury before presentation, organs injured, complications, and outcome were transferred into Excel spread sheet and analyzed using SPSS version 27. Results are presented in tables, with frequencies and percentages, means and charts.

Ethical clearance was obtained for this study.

III. RESULTS

Fifty five (55) patients presented with traumatic diaphragmatic injury, out of a total 1078 severe thoracic and abdominal trauma patients admitted through the accident and emergency unit over the 12-year period. This indicates an average of 4.6 patients per year with traumatic diaphragmatic injury. The demographic characteristics of the patients are as shown in Tables 1 and 2, and Figure 1, with 48(87.3%) being males while 7(12.7%) were females giving an M: F of 6.9:1. Thirty patients (54.6%) were between the ages of 20-29 years and 14(25.5%) between 30-39 years accounting for the highest proportion. For both sexes the age range of 20 - 29 had the highest frequency. The mean age at presentation was 25.56±7.16. Mechanism of injury was predominately penetrating as shown in Figure 2 and Tables 3a and 3b, with gunshot injury alone accounting for 31(56.4%), and stab injury 18(32.7%). Distribution of side affected were 37(67.3%) on the left, 17(30.9%) right and 1(1.8%), centrally as shown in Figure 3. All the patients had injuries to other structures, with the stomach being the most frequent abdominal organ injured having 46 patients (83.6%), followed by the small intestine with 12.7%; while the lungs was the most on the thoracic side with 9(16.4%) of the total, as shown in Table 4. Forty people, representing 72.7% of the patients presented within 9 hours while 14.5% presented after 24 hours as seen in Figure 4 and Table 5. The duration of hospital stay is as shown in Figure 4, with a mean of 19.4 days. Table 6 shows and compares duration of hospital stay to mechanism of injury while Table 7 compares mechanism of injury to outcome.The commonest complication is surgical site infection as shown in Table 8, and the mortality rate is 5.5 as shown in Figure 5.

Table 1: Age distribution of patents

Age group (years)	Frequency	Percent	Mean±SD
< 20	9	16.4	
20-29	30	54.5	
30-39	14	25.5	
40+	2	3.6	
Total	55	100.0	25.56±7.16

Table 2: Age and Sex Distribution of patient

Age group (years)	Sex			χ^2	P
	Male	Female	Total		
< 20	8(16.7)	1(14.3)	9(16.4)		
20-29	26(54.2)	4(57.1)	30(54.5)		
30-39	12(25.0)	2(28.6)	14(25.5)		
40+	2(4.2)	0(0.0)	2(3.6)		
Total	48(100.0)	7(100.0)	55(100.0)	0.559	0.999

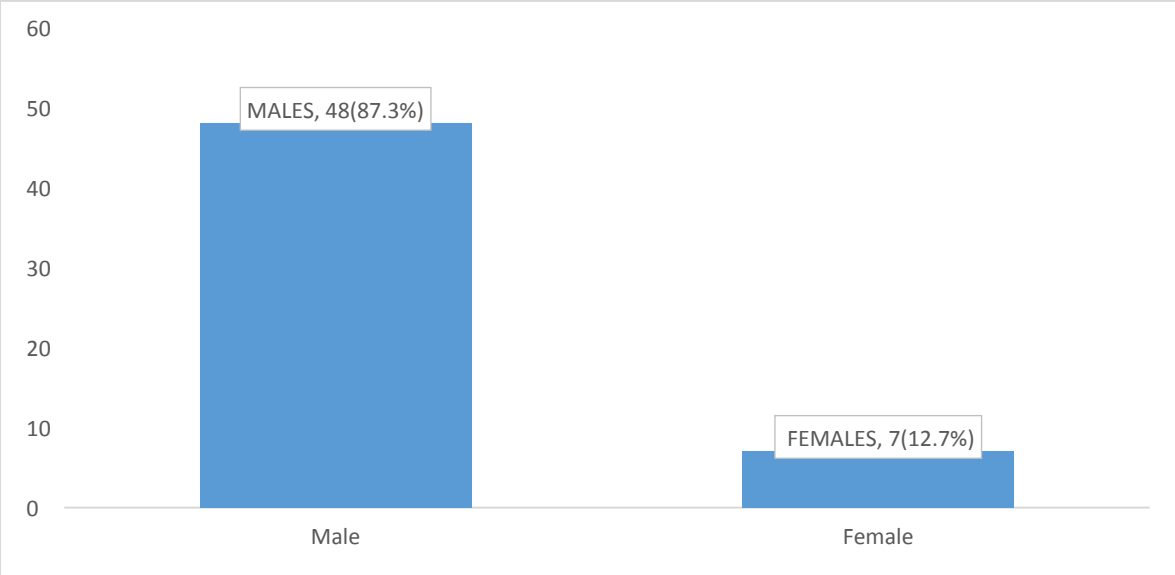

Figure 1: Sex distribution of patients

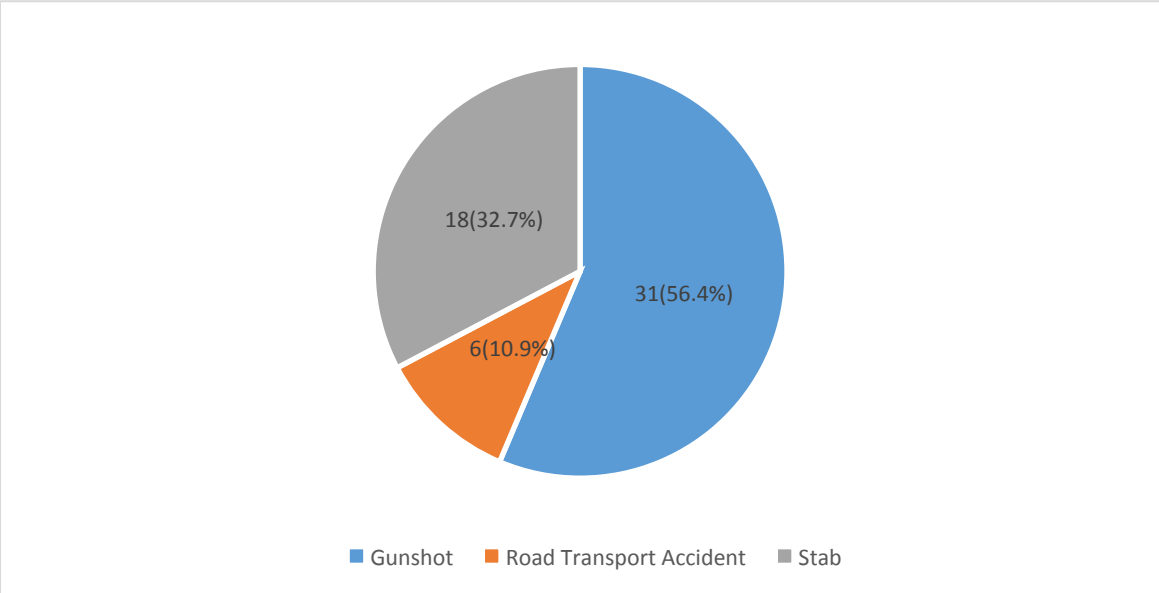

Figure 2: Distribution by Etiology

Table 3a: Distribution by etiology

Mechanism	Frequency (f)	Percent (%)
Penetrating	49	89.1
Blunt	6	10.9
Total	55	100.0

Table 3b: Distribution by etiology

Mechanism	Frequency (f)	Percent (%)
Stab	18	32.7
Gunshot	31	56.4
Blunt	6	10.9
Total	55	100.0

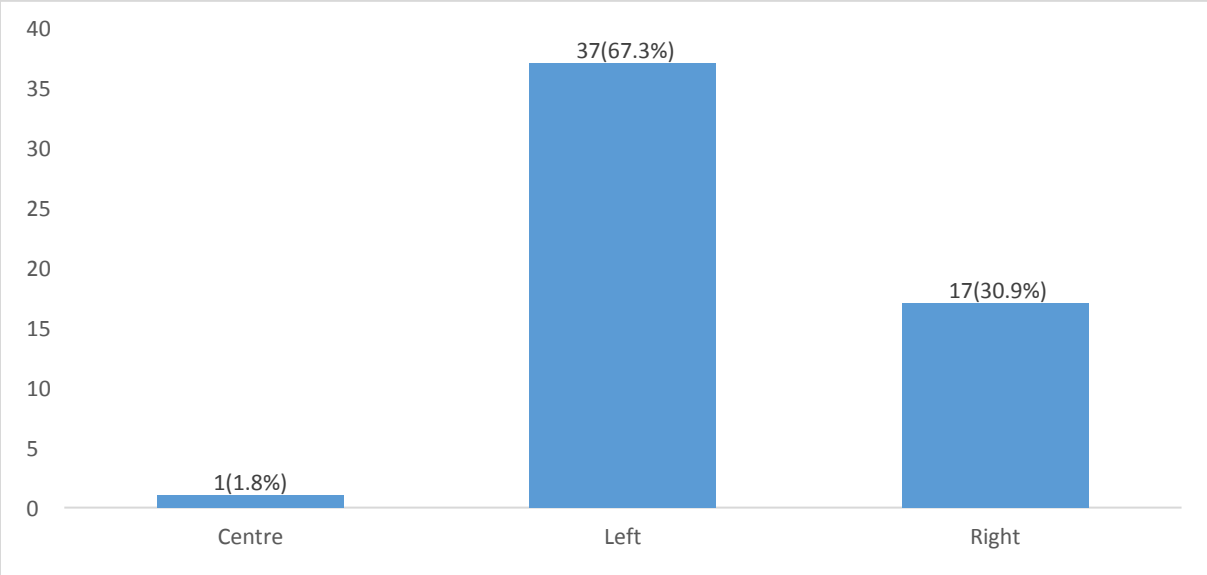

Figure 3: Side of lesion

Table 4a: Organs injured

Organs injured	Frequency	Percent
Stomach	46	83.6
Lungs	9	16.4
Small intestine	7	12.7
Spleen	4	7.3
Transverse colon	9	16.4
Liver	7	12.7
Gall bladder	2	3.6
Kidney	1	1.8
Right femur	2	3.6
Spinal Cord	1	1.8

Table 4b: Organs injured by Mechanism

Organs	Mechanism			
	Penetrating	Blunt	Total	p-value
Stomach	44(88.0)	6(12.0)	50(100.0)	0.999
Small intestine	7(100.0)	0(0.0)	7(100.0)	0.999
Spleen	3(75.0)	1(25.0)	4(100.0)	0.379
Transverse colon	8(88.9)	1(11.1)	9(100.0)	0.999
Liver	7(100.0)	0(0.0)	7(100.0)	0.999
Gall bladder	2(100.0)	0(0.0)	2(100.0)	0.999
Kidney	1(100.0)	0(0.0)	1(100.0)	0.999
Right femur	2(100.0)	0(0.0)	2(100.0)	0.999
Spinal Cord	1(100.0)	0(0.0)	1(100.0)	0.999

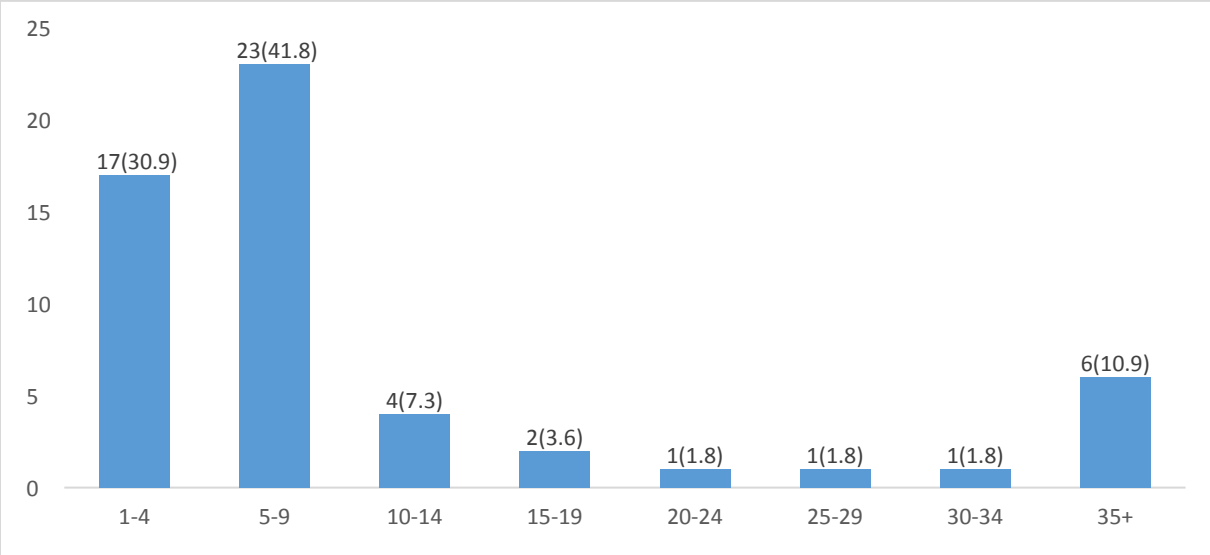

Figure 4: Duration of injury

Table 5: Duration of injury vs Mechanism of injury.

	Mechanism		
Duration	Penetrating	Blunt	Total
1-4	16(94.1)	1(5.9)	17(100.0)
5-9	21(91.3)	2(8.7)	23(100.0)
10-14	2(50.0)	2(50.0)	4(100.0)
15-19	2(100.0)	0(0.0)	2(100.0)
20-24	1(100.0)	0(0.0)	1(100.0)
25-29	1(100.0)	0(0.0)	1(100.0)
30-34	1(100.0)	0(0.0)	1(100.0)
35+	5(83.3)	1(16.7)	6(100.0)
Total	49(89.1)	6(10.9)	55(100.0)

χ^2 (Fisher's) = 5.085, p = 0.333

Table 6: Duration of hospital stay Vs. Mechanism

Duration (Days)	Mechanism		
	Penetrating	Blunt	Total
≤ 7	5(83.3)	1(16.7)	6(100.0)
8-14	17(89.5)	2(10.5)	19(100.0)
15-21	10(90.9)	1(9.1)	11(100.0)
22-28	6(85.7)	1(14.3)	7(100.0)
29-35	6(100.0)	0(0.0)	6(100.0)
36+	5(83.3)	1(16.7)	6(100.0)
Total	49(89.1)	6(10.9)	55(100.0)

χ^2 (Fisher's) = 2.037, p = 0.999

Table 7: Mechanism Vs Outcome

Mechanism	Outcome		
	Died	Alive	Total
Penetrating	2(4.1)	47(95.9)	49(100.0)
Blunt	1(16.7)	5(83.3)	6(100.0)
Total	3(5.5)	52(94.5)	55(100.0)

χ^2 (Fisher's) p = 0.298

Table 8: Complications

Complications	Frequency	Percentage
Non	25	45.5
Surgical site infection	20	36.4
Subphrenic abscess	1	1.8
External gastrointestinal fistula	2	3.6
Burst abdomen	1	1.8
Empyema	1	1.8
Diaphragmatic hernia	1	1.8
Paraplegia	1	1.8
Death	3	5.5
Total	**55**	**100**

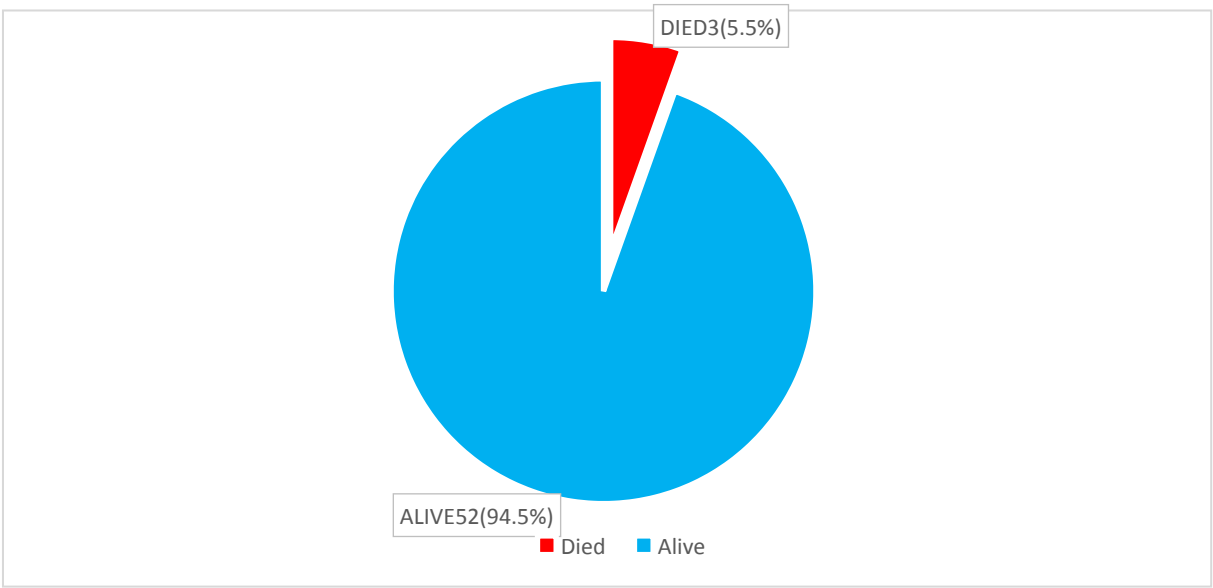

Figure 5: Outcome

IV. DISCUSSION

Diaphragmatic injuries are relatively uncommon but serious injuries occurring in 0.8 to 15% of all chest and abdominal trauma. [9,10] In this study we found 55 patients with diaphragmatic injuries, out of 1078 significant chest and abdominal injuries over a 12 year period, representing 5.1% of all combined severe chest and abdominal injuries. This shows an average of 4.6 patients per year which is higher than the 1.3% reported from Dakar, but lower than the 5.5% reported from Mali. [9,11] There were more males affected with M: F of 6:9. Peak age affected was between ages 20 to 29 years. Thus the age and sex distribution are in keeping with literature of severe trauma affecting young adult males. [12-15]

Left side and left dome of the diaphragm was mainly affected as shown in Figure 3. This may be because of a number of issues which include protective effect of the liver on the right side, areas of congenital weakness on the left, and the fact that left-sided injuries are easier to detect on X-rays.[1] Up to 32.7% of the etiology is from stab injuries as shown in Table 3b, and since most assailants are right handed we opine that it may also explain or contribute to the higher rate on left side. [16]

Penetrating injury was the predominant mechanism in this study, with blunt injury accounting for 10.9% as shown in Table 3b. This also is in keeping with most studies. [3, 17]Gunshot injuries accounted for 56.4% of the patients, which is rather worrying in a civilian population during peace time. We opine that this may be due to increasing proliferation of light arms in circulation in our city. [14, 15] Also the high number of ethno-religious crisis in the region within the study period increased the number of gunshot injuries. [18,19] However the finding is in keeping with studies from most centers. [20,21]

There was no isolated diaphragmatic injury in our series as the diaphragm was injured along with other structures, with the stomach being the most frequent and the lungs the most on the thoracic side as shown in Table 4a. Expectedly the risk of injury to other structures was higher in penetrating injuries and even then with gunshot subset of the penetrating mechanism as indicated in Table 4b.

Duration of injury with the highest number of patients (72.7%) before presentation and intervention was between 5 to 9 hours for both blunt and penetrating injuries as shown in Figure 4. We expected the penetrating injuries to present earlier than the blunt ones as is in the literature, but there was no statistical significance in our study as seen in Table 5. [8,9,10,17]

All our patients had laparotomy for definitive treatment of the diaphragmatic injury mainly because all the patients presented with abdominal symptoms and signs, and the readily available focused assessment with sonography for trauma (FAST). In addition, most of the thoracic component of this injury could be managed by chest tube thoracostomy which all our patients had. [7-11]

Most of the complications were infective, seen in 45.4% of the patients, the commonest being wound infection in 20(36.4%) patients as shown in Table 8. This can be explained by the presence of luminal gut perforations and subsequent peritonitis in most of the patients, and the penetrating mechanisms of the injuries making these wounds at the least untidy by Rank and Wakefield classification, with a high infection rate. [22] Diaphragmatic hernia occurred in a patient which was repaired via the abdominal route. Another patient with lung parenchymal injury developed empyema thoraces, and had thoracotomy with decortication of the empyema.

Mortality rate in this study is 5.5%. This is similar to findings of Thiam O. et al in 2016[9], and lower than in most other studies. [3,7,10,12,17]Though comparing the mechanism of injury with mortality was not statistically significant (P= 0.298) as shown in Table 8, it is noteworthy to state that the only mortality from blunt injury in this study occurred in the only missed diagnosis of diaphragmatic injury in this study.

V. CONCLUSION

Traumatic diaphragmatic injury commonly involve young adult males, and commonly from penetrating mechanism mainly from firearms. Left side is the side most affected, and stomach is the most other organ injured. Delayed presentation, missed injury, firearm injuries and central location is associated with higher mortality. Laparotomy remains an effective modality of treatment.

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