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Traumatic Diaphragmatic Rupture, Incidence, Presentation, and Outcome

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Abstract: Objective: The aim of this prospective study is to highlight the incidence of a traumatic diaphragmatic rupture occurring in thoraco-abdominal penetrating or blunt trauma, and discuss their presentation and outcome

Methods: We performed a prospective study, between 1st January 2017 to 30th June 2020 at the Department of General Surgery of the Al-Thawra Modern General Hospital, and 48-Modrn hospital -Sana'a city -Yemen. We included all the patients who were diagnosed and admitted with traumatic diaphragmatic rupture during the study period. Data included demographics, mechanism of injury, associated injuries, time of presentation post- trauma, length of hospital stay and ICU, ventilator days, management, postoperative complication, and outcomes. The variables were analyzed and compared for patients.

Result: A total of 38 patients had traumatic diaphragmatic injury of (1843) thoracoabdominal trauma (2.1%)(855 blunt trauma & 988 penetrating trauma), 31 patients (81.6%) have sustained penetrating trauma, while only 7 patients (18.4%) have blunt trauma. There were 33 male patients (86.8%) and 5 female patients (13.2%) with a mean age of 25 years (range 3–52 years), the location of rupture was 30 patients (78.9%) on the left-sided, and 8 patients (21.1%) on right-sided, 4 patients presented early with a diaphragmatic hernia, and 5 patient presented late with diaphragmatic hernia. Associated injuries were presented in 36 patients (94.7%). The diagnosis was preoperatively established in (36.8%), and intraoperative (63.2%). The diaphragmatic rupture was repaired with interrupted nonabsorbable sutures. Postoperative complications were observed in 23 patients (60.5%). Mortality was observed in 4 patients (10.5%). The outcome affected by associated injuries hemo/pneumothorax, rib fractures/lung contusion, hollow viscous injury, post-operative complication, time of presentation post- trauma, and hemodynamically state before admission.

Conclusion: Traumatic diaphragmatic rupture, usually masked by multiple associated injuries which aggravate the condition of patients and are responsible for morbidity and mortality**.** The left-sided is involved more than the right-sided.

Keywords: Traumatic diaphragmatic rupture**,** Blunt**,** penetrating, thoracoabdominal.

تمزق الحجاب الحاجز الرضحي؛ مدى شيوع الإصابة والعرض والنتيجة

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المستخلص: الهدف من هذه الدراسة الاستطلاعية، هو تسليط الضوء على الإصابة بتمزق الحجاب الحاجز الرضحي الواقع في منطقتي الصدر والبطن بعد الاصابات النافذة او الاصابات الرضية الحادة/الكليلة. اجريت هذه الدراسة في الفترة ما بين الأول من كانون الثاني (يناير) 2017 إلى الثلاثين من حزيران (يونيو) 2020 في قسم الجراحة العامة بمستشفى الثورة العام الحديث ومستشفى 48الحديث - مدينة صنعاء-اليمن؛ حيث قمنا بتضمين جميع المرضى الذين تم تشخيصهم وادخالهم إلى قسم الجراحة العامة كإصابات تمزق الحجاب الحاجز الرضحية خلال فترة الدراسة. وقد شملت هذه الدراسة المتغيرات التالية: البيانات الديموغرافية، آلية الإصابة، نوع الإصابة، الاصابات المصاحبة، وقت وصول المريض للمستشفى بعد الإصابة، وقت ظهور الاعراض بعد الإصابة، مدة اقامة المريض في المستشفى، مدة بقاء المريض في وحدة العناية المركزة، بقاء المريض على التنفس الصناعي، طرق المعالجة، ظهور المضاعفات بعد التدخل الجراحي، الحصيلة/ المخرجات النهائية للمرضى.

اثبتت الدراسة وجود 38حالة إصابة بتمزق الحجاب الحاجز الرضحي من بين 1843 حالة إصابة في منطقتي الصدر والبطن، وكان مدى شيوع الإصابة بنسبة (2.1%)، منها 988 حالة إصابة نافذة لمنطقتي الصدر والبطن و855 حالة إصابة كليلة لمنطقتي الصدر والبطن. كان من بين ال 38 حالة، 31 حالة (81.6%) تمزق بعد إصابة نافذة، و7 حالات (18.4%) تمزق بعد إصابة كليلة. عدد حالات الذكور 33 حالة (86.8%) وحالات الاناث 5 حالات (13.2%)، معدل العمر حوالي 25 سنة.

كانت 30 الإصابة تمزق في الجانب الايسر (78.9%)، و8 إصابات تمزق في الجانب الأيمن (21.1%)، من بين هذه الإصابات 4 حالات وصلت في المرحلة المبكرة تعاني من تمزق الحجاب الحاجز الرضحي ودخول احشاء البطن إلى تجويف الصدر.

الإصابات المصاحبة وجدت في 36 حالة (94.7%) حيث تم تشخيص 14 حالة قبل التدخل الجراحي (36.8%)، و24 حالة اثناء التدخل الجراحي (63.2%). تم اصلاح تمزق الحجاب الحاجز الرضحي بواسطة خيوط البرولين الغير قابلة للامتصاص. حدثت مضاعفات بعد التدخل الجراحي في 23 حالة (60.5%)، و4 حالات وفيات (81.6%).

المخرجات النهائية للمرضى تأثرت بوجود الإصابات المصاحبة (نزيف في الصدر/ استرواح الصدر، كسور في الأضلاع، وتضرر الرئة، الإصابات النافذة للأعضاء المجوفة، المضاعفات بعد التدخل الجراحي، زمن وصول المريض بعد الإصابة إلى المستشفى، العلامات الحيوية للمريض قبل دخول المستشفى. وهذه الدراسة توصلت إلى أن تمزق الحجاب الحاجز الرضحي عادتا مخفي بسبب الإصابات المتعددة المصاحبة التي تؤدي إلى تفاقم حالة المرضى وتكون مسؤولة عن المراضة والوفيات. الجانب الأيسر مشتمل أكثر من الجانب الأيمن.

الكلمات المفتاحية: تمزق الحجاب الحاجز الرضحي، الإصابة الرضية الكليلة، الإصابة النافذة، منطقة الصدر والبطن.

1. Introduction.

Traumatic diaphragm rupture poses both diagnostic and therapeutic challenges. The diaphragm is a thoracoabdominal structure, surgically, the diaphragm can be approached through the chest cavity or abdomen cavity via open or minimally invasive techniques. The preferred approach is often determined by the associated injuries [(1)]. Traumatic diaphragmatic rupture is an infrequent diagnosis in trauma patients with a reported incidence in various series between 0.8 - 8% in blunt trauma and 10-15% in penetrating trauma [(2)(3)]. But the true incidence is likely higher due to missed or delayed diagnosis. [(4)]Traumatic diaphragm injuries can often be missed even during exploratory laparotomy; with one series demonstrating 14% of traumatic diaphragm injuries were missed at an initial laparotomy [(5)]. This is likely due to the lack of a high index of suspicion and the difficulty with direct visualization of the hemi-diaphragms. Although local incidence as low as 0.2% has been reported [(6)]. The largest published series to

date on the incidence of Traumatic diaphragm rupture is from the American College of Surgeons National Trauma Data Bank in 2012 in which 833, 309 patients were analyzed. Traumatic diaphragm rupture incidence was 0.46% [7]. In a recent review of 53, 031 patients admitted to trauma centers, a total of 592 were found to have Traumatic diaphragm rupture, accounting for 3% of all patients [8]. In another review of 952, 242 patients in 565 trauma centers in The USA over a period of 4 years, 6038 patients had diaphragmatic injuries (0.63%) [9]. The overall incidence of Traumatic diaphragm rupture is exceedingly low but, prompt diagnosis is essential, as a missed injury is associated with significant morbidity and mortality (30% to 60%) [1] [10]. Morbidity can include anything from organ herniation and strangulation to severe respiratory compromise and even death [11] [12].

The diagnosis of traumatic diaphragm injuries can be difficult but is critical, as a delayed diagnosis can carry significant squeal. Traumatic diaphragm rupture can occur with both penetrating and blunt trauma and are often occult. Patients may vary in their presentation based on the extent and location of the injury, the present and extent of abdominal visceral herniated, and the presence of other injuries. For this reason, the mechanism of injury plays a crucial role in establishing a high index of suspicion for diaphragmatic injuries [10].

The mechanisms underlying blunt and penetrating diaphragmatic rupture are completely different. Because blunt Traumatic diaphragm rupture is usually caused by momentary high energy damage and is associated with life-threating injuries. It is generally considered to be a marker of severe trauma [13].

Traumatic diaphragm injuries divide into three categories based on the time from injury. The acute phase occurs from the time of injury until apparent recovery. The latent phase includes both symptomatic and asymptomatic patients without the presence of acute obstruction or strangulation. The obstructive phase occurs when the hernia becomes incarcerated and can progress to strangulation, necrosis, and perforation

Although historically traumatic diaphragm rupture was rare, their incidence has increased in modern times [17]. In 1541, Sennertus described a Traumatic diaphragm injury with gastric herniation on autopsy after a stab wound. Ambroise Paré reported a similar finding in 1578 in a soldier with colonic strangulation after a missed traumatic diaphragm injury from a stab wound [4][18][7]. The first ante-mortem diagnosis is accredited to Bowditch in 1853 [9]. Riolfi reported the first successful repair of a diaphragmatic hernia, and Walker reported the first repair of a trauma-related hernia in 1900 [18]. The high morbidity and mortality associated with traumatic diaphragm injuries were appreciated after World War I with an increase in strangulated diaphragmatic hernias, and by 1951, Carter published the first comprehensive review on Traumatic diaphragm injuries [19] [20].

2. Patient and methods

2.1 study design and setting

Descriptive prospective study of patients with traumatic diaphragmatic injuries of all age groups and gender admitted to Al-Thawra Modern General Hospital, and 48 Modern hospitals, from 1st June 2017 to 30th June 2020 located in Sana'a city -Yemen.

2.2 participants

All patients admitted to the Al-Thawra Modern General Hospital, and 48 Modern hospitals, following injury by penetrating or blunt trauma to the thoracoabdominal area, the upper boundary of the fourth intercostal space (anterior), the sixth intercostal space (lateral), the eighth intercostal space (posterior) and the lower edge of the ribs, during study period, then all diagnosed diaphragmatic injury preoperative or intra- operative, were enrolled and included in the study. Patients who meet the inclusion criteria were requested to consent before being enrolled in the study. The files of patients who underwent diaphragmatic repair were examined. The medical history, follow up schedules, and operation report were reviewed. Patients with penetrating or blunt trauma to the thoracoabdominal area who died before initial assessment, admission, and patients with iatrogenic diaphragmatic injury were excluded from the study.

2.3 Variables

The variables studied included demographics, such as age and gender, time of presentation to hospital post- trauma (early or late), mechanism of injury, case of injury, anatomical sit of the external wound, associated organ injuries and it's management, time and mode of diagnosis, surgical approach and surgical technique, complication post-surgical operation and it's management, hospital length of stay, ICU length of stay, mechanical ventilator stay, and Outcome was measured by calculating (completely curd, mortality, and morbidity patients).

All patients were followed up till discharge or death. After discharge patients followed up at the surgical outpatient clinic for 3-8 months. This information was collected using a pretested questionnaire.

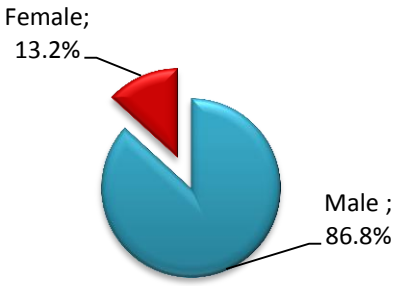
2.4 Statistical Analysis

All variables' were reviewed and entered into a computerized database system, statistical data analysis was done using SPSS software version 20. Data was summarized in form of proportion and frequency tables for categorical variables. Continuous variables were summarized using means, median, mode and stander deviation. P-values were computed for

Categorical variables using Chi-square, independent student t-test was used for continuous variables. Univariate logistic regression analysis was used to determine predictor variable that are associated with outcome. A p-value of less than 0.05 was considered to be a statically significant.

3. Result

During the study period, a total of 1843 patients were admitted and treated for thoracoabdominal trauma (blunt trauma855&988 penetrating trauma), and 38 cases (2.1%) were identified to have traumatic diaphragmatic injuries. The study identified 33 male patients (86.8%) and 5 female patients (13.2%) figure 1, ranging in age from 3 to 52 years of age (mean 25 years)



Figure(1) Disturabution of patient according to gender

The peak incidence of traumatic diaphragmatic injuries was highest in age group 21-30 years old 16 cases (42.1%), followed by the age group 10-20 years old 10 cases (26.3%), and age group from 31-40 years 9cases (23.7%). Table 1

Table (1) Distribution of patients according to age group

Age groups	No. of patients	Percent%
Less than 10 years	2	5.3%)
From 10 - 20years	10	26.3%
From 21-30years	16	42.1%
From 31-40years	9	23.7
>50 years	1	2.6%
Total	38	100%

The Penetrating diaphragmatic injury 31 cases (81.6%). blunt diaphragmatic injury was 7cases (18.4%). The main cases bomb explosion(n=14, 36.8%), gunshot wounds (*n*=10, 26.3%), stab wounds(*n*=7, 18.4%), road traffic accident (n=4, 10.5%), falling from height (n=2 case 5.3%), motor vehicle collisions (n=1, 2.6%).Traumatic diaphragmatic rupture location were on the left-sided for 30 patients (78.9%) and only 8 patients (21.0%) on the right-sided, and no cases on both sides. The majority of patients with traumatic diaphragm rupture presented to the emergency department to penetrate thoraco-abdominal trauma in 31 cases (81.6%). The external wound was thoracic in twenty-three cases, abdominal in three cases (2.6%), and five cases on both. The majority of patients presented to hospital have blunt or penetrating thoraco-abdominal trauma in acute phase in 33 case (86.8%), and 5 patients (13.2%) presented in delayed phase. Thoracoabdominal contusion seen in seven cases post blunt trauma, the majority of wound post penetrating injuries of the thoracoabdominal area was on the lateral side

below the level of 6 intercostal space 16 cases, 6 cases on the anterior side, and 9 cases on the back below the level of eight 8 intercostal space. The majority of patients presented to emergency department in the acute phase in <12hrs post exposure to trauma n=25, (65%), eight patients had arrived at 12-48hrs. In delayed phase 3 patients presented to hospital post trauma 6 month, 8 month, and one year, respectively, post blunt trauma, and 2 patient presented 3 and 5 days post penetrating trauma.

Eighteen patients (47.4%) presented to emergency department hemodynamically unstable with systolic blood pressure less than 90 mmHg, five patient stabilized in emergency department, thirteen patients shift to operation room, the majority of patients had Glasgow coma scale (9-15) 35 patients (92.1%), and three patients had Glasgow (6-8) 7.9%

Herniation of the intra-abdominal organs into the thoracic cavity through a ruptured diaphragm was present in 9 of 38 patients (26.3%) and was localized to the left hemidiaphragm in all diaphragmatic hernia (100%). The diaphragmatic hernia in acute phase was presented in 4 patients, and 5 patients presented in delayed phase, 2 patients (post trauma 3 and 5 days) and 3 patients presented in (6 months, 8 months, and one year), respectively, no patients presented in obstructive phase. The stomach was the organ most frequently found herniating into the thoracic cavity in 7 case (18.4%), followed by colon in 6 case (15.8%), spleen in 5 case (13.2), omentum in 4 case (10.5%) and small bowel in 3 case (7.5%), no case presented with herniated liver 0.0% (figure 2)

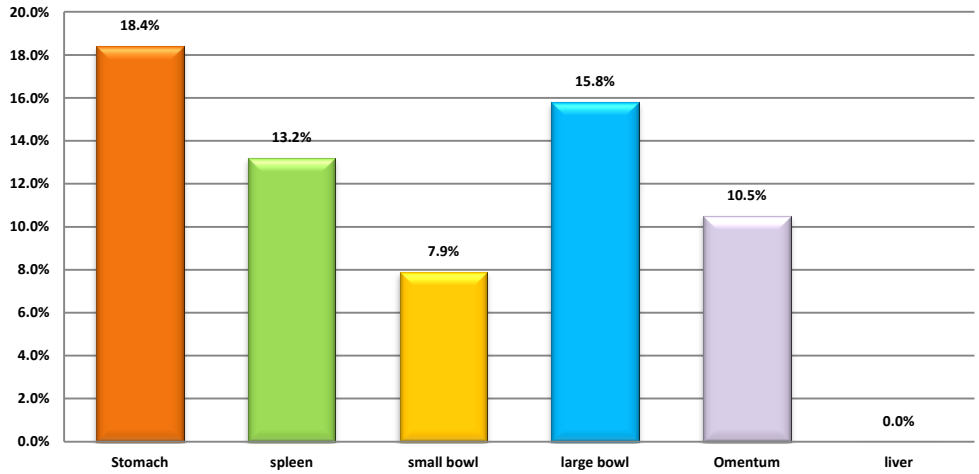


Figure (2) Distribution of patients according herniated viscera through diaphragmatic rupture

The associated injuries presented in 36 of 38 (94.7%), most anatomical site effected chest 28 patients 73.7%. most anatomical site effected thoracic 28 patients (73.7%) haemothorax *n*=25, punmothorax *n*=20, ribs fractures *n*=11, pulmonary contusion *n*= 4, followed by abdomen 24 patients (63.2%) stomach *n*=16, liver n=13, large bowle *n*=12, spleen *n*=12, small bowel *n*=4, kidney *n*=2 and pancreas *n*=1, gall bladder *n*=1. Orthopedic 10 patients (31.2%) pelvic=4, lower limb=5, upper limb= 5 and head injury in 3 patients (7.9%). (See table 3)

Table (3) Distribution of patients with diaphragmatic rupture according to associated injury

Associated injuries	Frequency	Percent%
Close head injury	3	7.9%
Ribs fractures	11	28.9%
Pulmonary contusion	4	10.5%
Haemothorax	25	65.8%
Pneumothorax	20	52.6%
Stomach	16	42.1%
Spleen	12	31.6%
liver	13	34.2%
Gall-bladder	1	2.6%
kidney	2	5.3%
Small bowl	4	10.5%
Large bowl	12	31.6%
Pancreas	1	2.6%
Upper limb	5	13.2%
Lower limb	5	13.2%
Pelvic	4	10.5%

Twenty-eight (73.7%) patients with traumatic diaphragm injuries diagnoses and treatments were established less than 24hrs. In ten patients 26.3%, the diagnoses and treatment delay ranged from 18hrs to 48hrs for 5 patients in acute phase, and 6 months, 8 months, and one year for 5 patients in delayed phase. Preoperatively diagnosed in 14 of 38 patients (36.8%), and 24 patients (63.2%) diagnosed incidentally during operation.

Initial operative approaches were laparotomy in 36 patients in acute and delayed phase presentation, thoracotomy in one patient with right side injury in acute phase post gunshot, and laparotomy thoracotomy for one patient.

An intraoperative description of the diaphragmatic rupture was available in 29 cases. The length of the diaphragmatic injury ranged from 2 to 18 cm. The parts of the hemidiaphragm involved were: the muscular part in17 cases, the tendinous part in 4 cases and both in 8 cases. The herniated abdominal visceral reduction, diaphragmatic rupture repair in two layers with interrupted and running techniques with no absorbable suture were used for all patients. No mesh used in the diaphragmatic repair.

Management of associated injuries in 36/38, 94.7% patients the operation included: stomach reappear (*n*=16, 44.4%), splenectomy (*n*=9, 25%), suture of the spleen (*n*=2, 5.5%), suture of the liver (*n*=10, 27.7%) with or without tissue debridement, packing of the liver (*n*=2,), nephrorrhaphy (*n*=2,

5.5%), colostomy (*n*=9, 25%) with Hartman colostomy (*n*=6) and loop colostomy (*n*=3), primary repair of the bowel (*n*=8, 22.2%), long-bone fractures fixation (*n*=7, 19.4%) and amputation (n=3, 8.3%).

Postoperative complications were encountered among 23 (60.5%) patients. The most common complication pulmonary complications occurred, postoperative complications were successfully treated conservatively in sixteen patients, and seven patients treated surgically, one patient underwent re-laparotomy for abdominal abscess, and three patients debridement for wound in operation room, three patients underwent thoracotomy for empyema.

The length of hospital stay was ranging from 3-60 days, the patients' mean hospital stay was 12 days. sixteen patients (42.1%) required mechanical ventilation postoperatively, for a short period (1-2 days), and five patients for a 3-5dayes. thirty-two patients (84.2%) were admitted and treated in the ICU, the mean ICU stay was 6 days.

The mortality rate was 10.5% (4/38). Mortality was significantly higher in the patients with penetrating trauma 4/31(10.5%) compared with those with blunt no mortality in the 7 patient (0.0%), among the mortality, two patient died from sepsis10, 18 days after surgery in the intensive care unit (ICU). two patient died in the day of operation due to nonreversible hemorrhagic shock, the most mortality patient post gunshot 3 patient, and one patient post stab wound.

The final outcome was 34 survivors 89.5% and 4 nonsurvivors 10.5%, among the survivors completely curd rate was 39.5% (15 patients), and morbidity rate was 50.0%, (19 patients): table 4. Among morbidity patients pneumonia (*n*=18, 94.7%), atelectasis (*n*=8, 42.1%), ARDS (*n*=8, 42.1%), lung contusion (*n*=3, 15.8%), empyema (*n*=5, 26.3%), multiple organ failure (*n*=1, 1.9%), acute renal failure (*n*=4, 21.0%), intraabdominal abscess (*n*=3, 15.8%), limb amputation (*n*=3), wound infection (n=12, 63). The follow-up time ranged from 2 months to 8 month for 19 patients (%) of 34 survivors, and 15 patients(%) lost.

Table (4) Distribution of patients with diaphragmatic rupture according to Outcome

outcome	Frequency	Percent%
Completely curd	15	39.5%
Morbidity	19	50.0%
Mortality	4	10.5%
Total	38	100%

4. Discussion:

The true incidence of traumatic diaphragmatic rupture is unknown because of either missing or overlooked diagnosis [21]. In the present study, the traumatic diaphragmatic rupture represented 2.1% of all thoracoabdominal contusion and penetrating chest and/or abdomen trauma. However, in our country the incidence of acute traumatic diaphragmatic rupture underestimate as the majority of cases mild and

missed or died before diagnosis due to severe trauma, and unavailability of routine postmortem examination in the state of Yemen. The incidence of traumatic diaphragmatic rupture has been reported as low as 0.2% [6]. The largest published series to date on the incidence of traumatic diaphragm rupture is from the American College of Surgeons National Trauma Data Bank in 2012 in which 833, 309 patients were analyzed. Traumatic diaphragm rupture incidence was 0.46% [7]. The incidence of traumatic diaphragm rupture ranges from 0.8- 7% in patients presented with blunt trauma and 10-15% for penetrating injuries [16], also reported an incidence of 4% of penetrating trauma and 0.5% of thoracoabdominal blunt trauma [25]. the incidence of diaphragmatic rupture was 0.2% in thoracoabdominal contusions and 2.1% in penetrating wounds [5]. In the present study the incidence of traumatic diaphragmatic rupture was 0.08% for thoracoabdominal contusion and 3.1% for penetrating wound.

In the present study, the traumatic diaphragmatic rupture was found to be most common in males than females and affect most in the second and third decade of life. The similar demographic observation was also reported by other authors [21] [22] [27]. This group in our country is the predominant population, male predominance in our study is due to their increased participation in high risk activities and participation in war in our country in the last years. In the present study, patients with traumatic diaphragm rupture had penetrating trauma 31 (81.6%) compared with blunt trauma 7 (18.4%) which is similar to report from (Hann a et al) found 63% penetrating trauma and 37% blunt trauma, and study done by Mohi-Aldain reported penetrating trauma 92.0% compare with blunt trauma 7.8%. A retrospective review of 15 years data from a Level -1trauma center also reported penetrating trauma (61%) compared with blunt trauma (39%) [20]. Also a retrospective review of 15 years data reported penetrating trauma to be the leading cause of traumatic diaphragm injuries (73%) [2]. And study done by Fair et al, who found (67%) of diaphragmatic injuries are caused by penetrating mechanism, were blunt mechanism (33%)[7].In contrast, other studies have reported higher incidence of traumatic diaphragmatic rupture with blunt trauma as compared with penetrating injuries [21][24][28]. And study by Shah et al, who reported a diaphragmatic injury rates by 75% in thoracoabdominal contusion and 25% in penetrating trauma.

These differences in mechanism of injury are caused by variation in demography and sociocultural conditions of our study population, which was mainly composed of males of the younger age group. Similar observation was also reported by the current literature that suggests the proportion of blunt to penetrating trauma varies according to the regional characteristics and sociodemographic factors.[6][20][30] In the present study, 31 patients 81.6% of traumatic diaphragm injuries were associated with penetrating trauma, with the main cause of penetrating trauma being post bomb explosion injuries 14cases(45.2%), gunshot 10 cases (32.2%), and stab wound 7 case(22.5%), this agree with study reported by Mohi-Aldeen [29] the main cause was blast injury, and gunshot.Our results are different to those of

other previously reported studies.[4][20][26][27] were the main cause of penetrating trauma was stab wounds and gunshot.

The present study also showed greater frequency of left side diaphragmatic injury after penetrating or blunt trauma 30 cases (78.9%), and the right diaphragmatic injury represent 8 cases (21.1%).Which is similar observation reported by other studies have reported higher incidence of left-sided than right-sided traumatic diaphragmatic rupture.[2][4][18][26][27]

All patients post blunt trauma have left hemidiaphragm injury 7/7(100%), and 23/31 patients(74.2%) of penetrating trauma suffering of left-sided injury, 10 patients post bomb explosion, 7 patient post gunshot, and 6 post stab wound, the higher prevalence of left-sided post stab wound, is also associated with the mechanism of penetrating wounds. There are more right handed assailants and thus a preference for wounding to the left side of the victim. All patients with right-sided have penetrating injuries, 4 patients post bomb explosion, 3 patient post gunshot, and one post stab wound.

The frequent of diaphragmatic injury on left side post blunt trauma is believed to be caused by less development of the diaphragm at its posterolateral portion, which is the weakest point. A thoracoabdominal pressure gradient develops, resulting in a rupture at the left diaphragm, usually after high-impact blunt trauma such as motor vehicle crash or fall from height The right diaphragm is stronger than the left side, and is partially protected by the liver [2][4][6].

Table (5) **: Review of Literature for Injury Characteristics, incidence and Outcome in Patients with traumatic diaphragmatic injuries.

References	Country of study	Duration of study	No of patients	incidence	MOI		Mortality
					Penetrating	Blunt	
Dirican et al[27]	Turkey	10	48/3668	1.3%	33	15	15%
Fair et al [7]	USA	1	3783/833309	0.46%	2543	1240	18%
Zaror et al [2]	USA	15	773/87294	0.8%	561	212	21%
Thiam et al [26]	Senegal	20	20/1535	1.3%	17	3	10%
Al-Thani et al [25]	Qatar	7	52/8000	0.7%	16	36	12%
Lim et al [31]	Singapore	11	46/13130	0.4%	11	35	54%

** Zaror et al [2] & Al-Thani H, et al [25]

In the present study, the majority of patients presented to hospital post trauma in acute phase 33 patient 92.1% the majority of patients presented to emergency department post trauma <12hrs 25 patients(75.8%), and eight patient presented between 18-48hrs, with no specific signs and symptoms in acute phase, most signs and symptoms of them related to associated injuries, most of the patients suffering from dyspnea, chest pain and pain in the upper abdomen. as seen in previous study [6][27], and 5

patients presented with diaphragmatic hernia in delayed phase, 3 patients post blunt trauma complaining of dyspnea on flat position, and 2 patients post penetrating trauma.

Eighteen patients presented with unstable vital sings mainly SBP less than 90mmhg, five patient stabilized in ED before admission, other patient admitted with unstable vital sings.

In the present study the time of presentation of patients post trauma with traumatic diaphragmatic injuries in acute phase has significantly effect on the outcome of our patients, p-value=0.001 for patient presented <12hrs, and p-value=0.296 for patient presented in 18-48hrs, for patients presented in delayed phase p-value=0.000.

Hemodynamically state was significantly affecting the outcome of our patients, p-value=0.019 in mortality patient admitted with unstable vital signs, p-value=0.009 in patient admitted with stable vital signs. Vitally unstable patients before admission has been reported significantly affect the outcome of patients with traumatic diaphragmatic injuries. As reported by author's [18][27].

In the present study, traumatic diaphragmatic hernia was present in 9 of 38 patient 23.7% and was localized to the left side of diaphragm in all cases, the diaphragmatic hernia not effect on the outcome of our patients p-value=0.448.

In the present study the presence of associated injuries is an important determinant of the outcome of traumatic diaphragmatic injuries is an agreement with finding from other studies done elsewhere [2] [6] [18].

In the present study, 94.7% patients had multiple injuries, the commonest associated injuries begin chest injuries in form of haem/pneumothorax *n*=32% p-value=0.008, ribs fractures/ pul-monary contusion *n*=14(10.5%) p-value=0.032, followed by, injuries to intra-abdominal organs, the hollow viscus (stomach, large bowel, small bowel,) injury was in 23 patients p -value=0.000, and solid organ (liver, spleen, kidney, gall-bladder, and pancreas) in 23 patient p-value=0.456, extremities'/and pelvic in 10 patient p-value=0.438.and closed head injury in 3 patient p-value=0.231.

The presence of associated injuries was found to be significantly associated with both mortality and morbidity. In the present study, Patient with thoracic injuries, and intra-abdominal hollow viscus injuries were significantly effect on the outcome of our patients, in compare to other associated injuries no significantly effect on the outcome.

Hanna et al. Reported head injury, ribs fractures, and hollow viscus injury found to be associated with outcome [14].

Early recognition and treatment of associated injuries is important to reduce mortality and morbidity associated with traumatic diaphragmatic injuries.

In the present study the early diagnosis of traumatic diaphragmatic injuries in less than 24hours established in 28 of 38 patients (73.3%), and >24 in 10 cases 36.8%. the most common diagnostic techniques in our study including plain chest X-ray, CT scan.

Laparoscopy, and video-assisted thoracic surgery(VATS), and fluoroscopic not used in our study in compare to other study [6]

In the present study, the diagnosis was preoperative in 14 of 38 (36.8%) of cases, intraoperative in 24 of 38 of cases (63.2%). Similar to study reported by authors. [15][26]. In contrast to other study [16][23][32]. The time of diagnosis not significantly effect on outcome p-value=0.426.

Surgical repair is necessary, even for small tears, because the defect will not heal spontaneously, and a surgical repair is easier to achieve before fibrosis develops. The parieto-peritoneal pressure gradients favor enlargement of the defect with herniation of abdominal contents [6]. The choice of surgical approach includes thoracotomy, laparotomy, or both if necessary, depends on the circumstances of each case besides the preference and expertise of the surgeon [1][27].

In the present study all patients with traumatic diaphragmatic rupture undergoing surgically repair in 37cases through abdominal cavity (32 cases in acute phase and 5 cases in delayed phase), and one patient through thoracic cavity for right-sided penetrating injury, only one patient demanded simultaneous thoracotomy for stop bleeding from the intercostal vessels. For the rest of the patients associated thoracic injuries were treated only by chest tube. This was consistent with other previously reported studies were the majority of the cases managed by exploratory laparotomy [2][21][25].Minimally invasive surgery not applied in our patients, also all operation in our study done in the night duty by doctors on duty. In the present study The routine surgical repair of the defect is accomplished by interrupted or continuous direct suture using a double layer of nonabsorbable suture without a mesh and evacuation of the involved pleural cavity with a chest tube, this finding is in similar to study done by [21].

In the present study, post-operative complications were seen in 23 (65.8%) of cases. The most common postoperative complications were pulmonary-related. The presence or absent of complication has an impact on the outcome of patients with diaphragmatic injuries as supported significantly by the our study, we finding p-value=0.000 for patient with Post-operative complication, and p-value=0.002 for patient without post-operative complication, which agrees with finding from other studies [15][30] [32].

Early recognition and treatment of post-operative complication is of important in reducing the mortality and morbidity resulting from these injuries. In the present study vast majority of post-operative complication management conservatively.

Early deaths usually are a result of associated injuries, not the diaphragmatic tear itself. The mortality rates vary from 1% to 28% in the previous literature [15] [21].

Mortality rate 10.5% in our series was lower than that reported by (Fair et al; 20%).

And slightly higher in comparison to study by (Thimm et al) the mortality rate was 5%.In our study no death was directly attributable to traumatic diaphragmatic injuries and this is in accordance with the literature. [17][18][19] The follow-up time ranged from 2 months to 8 month for 19 patients (55.9%) of 34

survivors, three patients suffering from recurrent chest infection, none of the follow up patients were found with recurrent diaphragmatic hernia or diaphragmatic paralysis. The other 15 patients (44.1%) lost.

5. Conclusion:

Traumatic diaphragmatic injury, usually masked by multiple associated injuries which aggravate the condition of patients and are responsible for morbidity and mortality. The left hemidiaphragm is involved more frequently than the right-hemidiaphragm, and all diaphragmatic hernia located in left side. Death is usually due to associated injuries and the high morbidity is mainly due to pulmonary complications. Factors responsible for mortality and morbidity associated injures of hollow viscus organs, unstable vital sings before admission, presence of postoperative complication.

6. Recommendations:

To avoid missed diaphragmatic rupture, careful inspection of the both hemidiaphragm is necessary with visual and manual evaluation of the surface of the diaphragm should be done routinely in every trauma patient undergoing laparotomy. Preoperative diagnosis of traumatic diaphragm rupture was made in a small number of patients, the trauma and surgical team must by improve radiological interpretive skills. In all cases with significant blunt thoraco-abdominal trauma, evaluation is required to exclude traumatic diaphragm rupture, and the follow-up assessment is needed to identify the delayed onset of traumatic diaphragm rupture after extubation or discharge in some cases.

Authors contributions

WG, YAO, AAM: designed the study. WG, YAO collected the data, analysis and interpretation of the result, and draft the manuscript. AAM revised the manuscript. All authors read and approved the final manuscript.

Conflicts interests

The authors have no conflict of interest associated with this article.

Ethical approval

Ethical approval to conduct the study was obtained before the commencement of the study. Informed consent was sought from each patient before being enrolled into the study.

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