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Postoperative Outcomes of Trans-abdominal Open Surgical Repair of Traumatic Diaphragmatic Hernias in Adults. Retrospective Observational Study

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ABSTRACT

Objective: Evaluation of our management of acute or chronic traumatic diaphragmatic hernia repair with sutures or mesh.
Patients and methods: Between January 2014 and January 2019, a retrospective study on 185 patients with acute and chronic traumatic diaphragmatic hernias was carried out at the general surgery department of Zagazig University. Results both during and after surgery were assessed.
Results: The median age of the patients was 42.6±8.3 years, with 81% being male. Blunt trauma was the most typical cause of diaphragmatic hernia (79% of cases). Acute and chronic diaphragmatic hernias had damage severity scores of 27.71±3.73 and 12.42±2.51, respectively. The left copula was the most common location for diaphragmatic hernias (89%), and they were typically less than 10 cm in diameter (82%), with 83% being sutured closed. The most typical organs affected by the hernia were the stomach (61%) and the spleen (38%). The average operation lasted 93± 20.2 minutes. One hundred one patients (101/133, 76%) experienced an isolated diaphragmatic hernia, whereas 32 patients (32/133, 24%) did so in conjunction with other organ injuries, the most frequent of which were splenic injuries (6/32), stomach injuries (4/32) and thoracic injuries (7/32). The median length of stay in the hospital was 9.63±3.11 days, while the median length of analgesic use was 4±2.1 days. The most frequent postoperative problems included wound infection (13%), ileus (2%), intestinal leak (3%), intra-abdominal abscess (3%), adherent intestinal obstruction (2%), incisional hernia (4%), recurrent diaphragmatic hernia (2%), totaling 18% of postoperative complications. Reintervention was necessary for 12.5% of patients, and the most frequent reasons were intestinal leak (2%), intra-abdominal abscess (3%), adhesive IO (1.5%), incisional hernia (4%), and recurrence (2%). Four cases of intraoperative death and 3 cases of postoperative death made up the 4% overall mortality rate (7 cases).
Conclusion: Suture or mesh repair of acute or chronic traumatic diaphragmatic hernia is safe, with minimal morbidity and mortality and a low recurrence rate.
Key words: diaphragmatic hernia, traumatic, repair, recurrent, mortality

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INTRODUCTION

Traumatic diaphragmatic hernias are the outcome of 0.8% to 6% of blunt

trauma cases and more than 17% of cases involving thoraco-abdominal-penetrating trauma (TDH) (1). Chronic traumatic diaphragmatic herniation (CTDH) is a condition that can develop as a result of an enlargement of a defect in the diaphragm brought on by a pressure difference between the thoracic cavity and the abdominal cavity (2). It is possible that the rupture will not heal on its own due to the inherent pressure difference that exists between the thorax and the abdomen as well as the continuous movement of the diaphragm (3).

Due to the seriousness of the related organs' injuries, traumatic diaphragmatic rupture presents a complex emergency and typically necessitates a high diagnostic suspicion. The herniated structures may strangulate into the thoracic cavity, and the mortality rate may increase considerably if the traumatic diaphragmatic hernia is not identified and treated in the acute phase of the trauma (4). These patients may not be diagnosed until weeks, months, or even years after the initial traumatic event, and they may present with acute symptoms related to the cardiovascular system and the digestive tract (5-6). A high mortality rate is seen in people with CTDH with viscera that have been strangulated (2,7).

Despite advancements in diagnostic technologies, 2.7 - 50% of patients still have a misdiagnosis (8). Early, accurate diagnosis is now more common thanks to greater experience and the emergence of imaging tools, particularly computed tomography (CT) (9).

A limited number of researches describe acute and chronic traumatic diaphragmatic hernias in terms of intraoperative and postoperative outcomes. To examine the intraoperative and postoperative results of patients with traumatic diaphragmatic hernias repaired using either suture repair or mesh repair in terms of morbidity, mortality rate, and incidence of recurrence, we have established a retrospective cohort analysis for the current investigation.

PATIENTS & METHODS

Study design and eligibility requirements: Between January 2014 and January 2019, 185 patients with acute and chronic traumatic diaphragmatic hernia underwent a retrospective observational study at the general surgery department of Zagazig University. Patients who were >18 years old, male or female, and had an acute or chronic traumatic diaphragmatic hernia met the inclusion criteria. Hiatus hernias, congenital hernias, diaphragmatic tears without herniation of abdominal organs, eventration of the diaphragm, hernias on both sides of the diaphragm, and recurrent diaphragmatic hernia after prior repair were all excluded from the study.

Definitions and outcomes measurements: Diagram injury scale was used to categorize the severity of diaphragmatic injuries (10). Postoperative morbidity and mortality were assessed according to the Clavien-Dindo classification (11). There is a grey area in the definition of chronic diaphragmatic hernia. Some authors define acute TDH as occurring within a certain period, such as seven days or one month, regardless of when the patient underwent surgery or was admitted to the hospital (12). Chronic TDH was characterized as a diaphragmatic hernia with a clear history of trauma that was not identified at the initial hospitalization. The operative surgeon meticulously documented the extent of the herniated organs and diaphragmatic ruptures. Clinical data was gathered, including demographic data, damage mechanisms and severity, clinical presentation, imaging techniques, hernia characteristics (side of hernia, organs in hernia or injuries, length of rupture, etc.), surgical techniques, duration of hospital stay, and outcomes.

Method

Chest X-rays and chest and abdomen CT scans are part of the preoperative workup (*fig. 1*). Antibiotics are administered intravenously with anesthesia induction. Four surgeons qualified in diaphragmatic hernia surgery performed all procedures in a single general surgery unit over 60 months, adhering to the guidelines. All patients underwent a laparotomy as the surgical approach, with no patients receiving a thoracotomy. After achievement of the hemostasis through 6

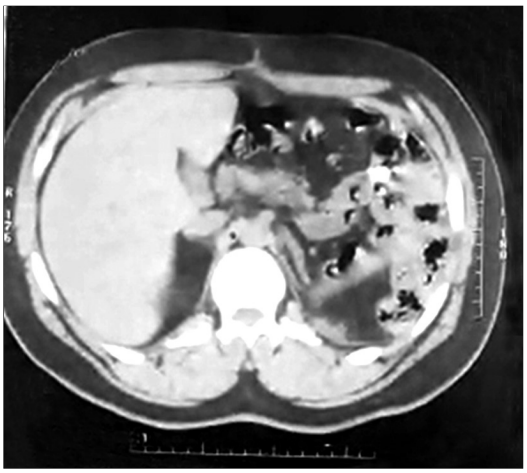

Figure 1 - CT abdomen and chest showing left-sided diaphragmatic hernia

Figure 2 - Laparotomy demonstrating stomach herniation inside left hemithorax.

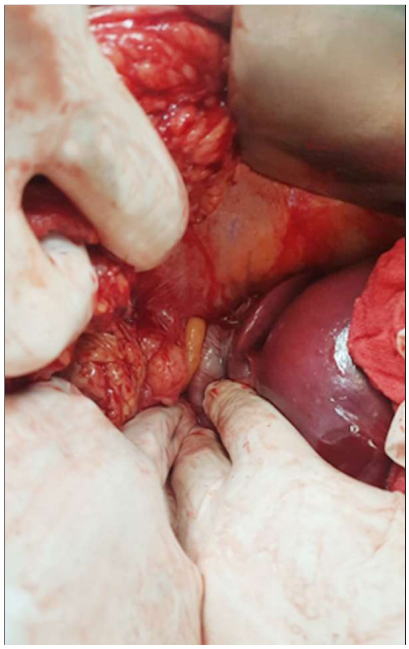

Figure 3 - Laparotomy demonstrating spleen and left colon herniation inside left hemithorax.

Figure 4 - Laparotomy demonstrating liver herniation inside right hemithorax.

splenectomies, three hemostatic sutures of hepatic injuries and repair of bowel injuries by intestinal resection and anastomosis (3 patients), and resection of the contused colon and subsequent colostomy (3 patients), stomach repair (4 cases), further exploration allowed the discovery of 165 left-sided (*figs. 2, 3*) and 20 right-sided diaphragmatic hernias (*fig. 4*). After repositioning the herniated organs, diaphragm defects (*fig. 5*) were directly closed, most commonly with double rows of continuous non-absorbable sutures or a figure of 8 sutures. Lesions > 10 cm (32 patients) required a prosthetic mesh repair (*fig. 6*). Abdominal drains were always placed while a chest tube was positioned in 4 cases. Following the patient's return home, a follow-up period of one month, six months, twelve months, twenty-four months, and 42 months was conducted via mail, phone, and at an outpatient clinic. Follow-up was done through history-taking and physical examinations to detect any complications; cases lost during follow-up were excluded from the study.

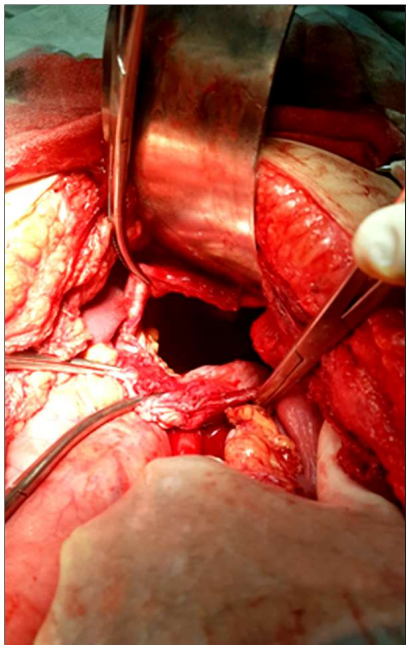

Figure 5 - Once the hernia has been reduced, the resultant diaphragmatic defect is demonstrated.

Figure 6 - Repair of the diaphragmatic defect by mesh repair.

Statistical analysis

The mean and standard deviation was used for continuously distributed variables with a normal distribution; for variables with an abnormal distribution, the median was used. Percentages represented categorical variables. S.P.S.S. version 20 was used for all statistical analyses (S.P.S.S., Chicago, IL).

RESULTS

The demographic and preoperative information for the group under study is shown in *table 1*. The median age of the patients was 42.6 ± 8.3 years, with 81% being male. Blunt trauma was the most typical cause of diaphragmatic hernia (79% of cases). Acute and chronic diaphragmatic hernias had damage severity scores of 27.71 ± 3.73 and 12.42 ± 2.51, respectively. While dyspnea was the most frequent presentation (57%), asymptomatic patients were found in 12% of patients. The acute diaphragmatic hernia was the most prevalent type (72%), and it was detected in most patients prior to surgery (73%). DM was the most prevalent comorbidity (14%).

The intraoperative data for the group under study are shown in *table 2*. The left copula was the most frequent location for diaphragmatic hernias (89%), and they were often less than 10 cm in diameter (82%) and mainly sutured together (83%). Hernias' most often affected organs were the stomach (61%) and spleen (38%). The average operation lasted 93 ± 20.2 minutes. One hundred one patients (101/133, 76%) experienced an isolated diaphragmatic hernia, whereas 32 patients (32/133, 24%) did so in conjunction with other organ injuries, the most frequent of which were splenic injuries (20/32) with subsequent splenectomy, stomach injuries (4/32) with 2 layered repair, liver injuries (3/32) with suture transverse mattress repair, colonic injuries (3/32) with repair and proximal covering stoma, small intestinal injuries (2/32) with subsequent resection and primary anastomosis, pancreatic injuries (2/32) with conservative treatment and thoracic injuries (7/32).

Postoperative parameters and complications are shown in *table 3*. The typical hospital stay was 9.63±

Table 1 - Demographic and preoperative data of the studied groups (n=185)

	N (%)
Gender	
• Male	150 (81%)
• Female	35(19%)
Age (years)	42.6 ± 8.3
Causes of trauma	
• Blunt	146(79%)
• Penetrating	39(21%)
Injury severity score	
• Acute	24.71 ± 3.73
• chronic	12.24 ± 2.51
Clinical presentation	
• Asymptomatic	22(12%)
• Dyspnea	105(57%)
• Upper abdominal Pain	61(33%)
• Strangulated viscus	22(12%)
BMI in kg/m^2 mean ±SD	32±2.14
Diagnosis	
• Preoperative	135(73%)
• Intraoperative	50(27%)
ASA status	
• I	83(45%)
• II	68(37%)
• III	18(10%)
• IV	16(8%)
Diagnosis:	
• Acute diaphragmatic hernia	133(72%)
• Chronic diaphragmatic hernia	52(28%)
Previous abdominal/pelvic surgery	22(12%)
• Steroid treatment	9(5%)
• Diabetes Mellitus	26(14%)
• Hypertension	13(7%)
• Coronary artery diseases	6(3%)

Table 2 - Intraoperative data in studied groups

	N (%)
Site of tear	
• LT copula	165(89%)
• Rt copula	20(11%)
Diaphragm injury scale	
• I (contusion)	13(7%)
• II (laceration < 2 cm)	97(52%)
• III (laceration 2-10 cm)	43(23%)
• IV (Laceration >10 cm with tissue loss < 25 cm^2)	22(12%)
• V (Laceration with tissue loss > 25 cm^2)	10(6%)
Types of repair used	
• Suture repair	153(83%)
• Mesh repair	32(17%)
Contents included in hernia	
• Stomach	113(61%)
• Spleen	70(38%)
• Small intestine	31(17%)
• Large intestine	9(5%)
• Liver	7(4%)
Types of repair	
• Acute suture repair	127(69%)
• Acute mesh repair	12(6.5%)
• Chronic suture repair	26(14%)
• Chronic mesh repair	20(10.5%)
Blood loss(ml)	
• Acute diaphragmatic hernia	600±100.3
• Chronic diaphragmatic hernia	200±120.3
Operative time in minutes (mean±SD)	93±20.2
Concomitant injuries in acute type (133 cases)	
Isolated diaphragmatic hernia	101/133(76%)
Associated with one or more system injury	32/133(24%)
1. Associated abdominal injury	20
• Splenic injury with splenectomy	6
• Stomach injury(repaired in 2 layers)	4
• Liver injury (suture repair)	3
• Colonic injury (repair with covering stoma)	3
• Intestinal (resection and primary anastomosis)	2
• Pancreatic (conservative treatment)	2
2. Associated Thoracic injury	7
3. Associated neurological injury	3
4. Associated orthopedic injuries	2

Table 3 - Postoperative parameters and complications

	N (%)
Hospital stay(days)(mean±SD)	9.63 ± 3.11 days
Time of analgesic intake(days))(mean±SD)	4±2.1
Wound infection (surgical site infection)	13(7%)
Ileus	4(2%)
intestinal leak	6(3%)
Intra-abdominal abscess	6(3%)
Adhesive Intestinal obstruction	4(2%)
Incisional hernia	7(4%)
recurrence	4(2%)
Surgical re-intervention	24(12.5%)
Causes of re-intervention	
• Intestinal leak	4(2%)
• Intra-abdominal abscess	6(3%)
• Adhesive IO	3(1.5%)
• Incisional hernia	7(4%)
• Recurrence	4(2%)
Clavien-Dindo classification	
0	146(79%)
I	13(7%)
II	12(6.5%)
IIIb	11(6%)
V	3(1.5%)
Overall postoperative complications	34(18%)
Overall mortality (at the end of the study)	7(4%)
Intraoperative mortality	4
• Gunshot with lung maceration	1
• Penetrating injuries with cardiac injuries and cardiac tamponade	1
• Brain death	1
• hemorrhagic shock	1
Postoperative mortality	3
• Intestinal injuries with fecal fistula and septic complications.	1
• Postoperative pneumonia	2

3.11 days, while the typical time for using analgesics was 4 ± 2.1 days. The most frequent postoperative problems included wound infection (13%), ileus (2%), intestinal leak (3%), intra-abdominal abscess (3%), adherent intestinal obstruction (2%), and incisional hernia (4%), recurrent diaphragmatic hernia (2%), totaling 18% of postoperative difficulties. Re-intervention was necessary in 12.5% of cases, and the most frequent reasons were intestinal leak (2%), intra-abdominal abscess (3%), adhesive IO (1.5%), incisional hernia (4%), and recurrence (2%). Four cases of intra-operative death and 3 cases of postoperative death made up the 4% overall mortality rate (7 cases).

DISCUSSION

Traumatic diaphragmatic hernias are dangerous sequelae after blunt and penetrating abdominal trauma. They may be diagnosed early during abdominal exploration or missed to be diagnosed later on after increased intra-abdominal pressure pushing the abdominal viscera to the chest with possible complications. This study aimed to evaluate the intraoperative and postoperative outcomes during and after open repair of traumatic diaphragmatic hernia. The commonest site of diaphragmatic hernia was through the left copula (89%) and mostly ≤ 10 cm in diameter (82%), mostly repaired by suture (83%). Stomach (61%) and spleen (38%) were the most common organs included in the hernia. The mean operative time was 93 ± 20.2 minutes isolated diaphragmatic hernia occurred in 101 patients (101/133, 76%) while diaphragmatic hernia associated with other organ injuries occurred in 32 patients (32/133, 24%) being splenic injuries (6/32), stomach injuries (4/32) and thoracic injuries (7/32) being the most common concomitant system injuries. The commonest post-operative complications were wound infection (13%), ileus (2%), intestinal leak (3%), intra-abdominal abscess (3%), adhesive intestinal obstruction (2%), incisional hernia (4%) and recurrent diaphragmatic hernia (2%) with overall postoperative complications was 18% reintervention occurred in 12.5% of cases with intestinal leak (2%), intra-abdominal abscess (3%), adhesive IO (1.5%), incisional hernia (4%) and recurrence (2%) were the most common causes of reintervention. The overall mortality rate was 4% (7 cases), with 4 cases died intra-operatively, and three died in the postoperative period.

Because of their association with additional intra-abdominal injuries in up to 100% of patients, acute traumatic diaphragmatic hernias have traditionally been repaired through abdominal incisions. On the other hand, a thoracic approach is more common for treating chronic diaphragmatic hernias (13-15). However, in our study, all cases were performed through the abdominal approach, and we did not find any difficulties in the dissection of organs or the repair of diaphragmatic tears. Furthermore, another study stated that the operative strategy relies on which departments deal with the patient. General surgeons use laparotomies in 92% of cases (8), and Thoracic surgeons perform thoracotomies in 78% of instances (16).

The organs on the left side of the body that herniate the most frequently are the spleen, stomach (80%), omentum, small intestine, and colon (17). We concur with the previous study that the stomach (61%) is the most frequently herniated organ in diaphragmatic hernia, with splenic injuries being the most frequently occurring abdominal organ damage. In many cases, the spleen herniated through a small-sized diaphragmatic

tear may explain the high frequency of splenic injuries. The surface of the diaphragm should be carefully examined visually and manually; it has been recommended to identify TDI. In our investigation, left-side diaphragm injuries were more frequent.

The diaphragmatic hernia may be isolated or associated with other system injuries. The most frequent injuries observed in blunt-trauma TDH patients are multiple rib fractures and pneumohemothoraxes (90%), with spleen injuries occurring in 27% to 60% of cases (18), while other study stated that common associated injuries include pelvic fractures (40—55%), splenic injuries (60%) and renal injuries (19). In our study, isolated diaphragmatic tears with diaphragmatic hernia occurred in 76% of cases, and associated other system affection occurred in the remaining cases, with splenic injuries and cardiothoracic injuries being the commonest associated organ injuries. Splenic injuries were the most often occurring organ injuries. This is probably because most of our cases of diaphragmatic hernia affect the left diaphragm copula. Because of an inherent weakness in its posterolateral aspect, injury to the left hemi diaphragm occurs more frequently than injury to the right hemi diaphragm. Additionally, the liver performs a protective role in right diaphragm injuries by preventing the herniation of the abdominal viscera (20).

Recurrent hernias are a severe problem. Various studies dealt with a recurrent diaphragmatic hernia concerning the type of repair, suture materials, and hernia defect size. The previous study's findings demonstrated that the use of absorbable sutures results in a hernia recurrence in a diaphragm that has been healed (8). According to the findings of another study, the hernia defect could be repaired using either non-absorbable or absorbable suturing material. Despite this, using non-absorbable suturing is the most commonly advised method (21). Interrupted and continuous suture repair strategies are beneficial to the same degree (22). According to the findings of another study, a simple suture is adequate for repairing the small defect, whereas larger defects require the use of synthetic mesh (8). In our study, we used non-absorbable continuous or figure-8 sutures to repair the diaphragmatic rupture and mesh to fix bigger defects greater than 10 cm; this leads to a decreased recurrence of diaphragmatic hernia (2%).

The morbidity rate was 48%, and the mortality rate was 24.4% in traumatic diaphragmatic hernia repair (23). In our study, the postoperative morbidity was 18%, and mortality was 2 % which is much lower than the previous study, most probably due to variation in the number of patients (33 patients in the previous study while 185 patients in our study), thoracic approach in 3 cases of the previous study while all our patients approached through abdominal approach and finally associated cardiothoracic injuries which is higher in the previous study than in our study (34.5% Vs. 3.8%). In addition, the trauma treatment was carried out by a single team directed by a general surgeon and comprised of orthopedic surgeons, cardiothoracic surgeons, and neurosurgeons. As a result of the surgeons' expertise in the surgical repair of organ damage, we could give quick and appropriate surgical therapy for patients who had sustained multiple injuries. These factors apparently contributed to an improvement in the survival rate of our TDH patients. Other studies found far greater mortality rates, reaching up to 60% (24-26)

CONCLUSION

Repair of traumatic diaphragmatic hernia, either acute or chronic, using suture or mesh repair, is safe with low morbidity and mortality and a low recurrence rate.

Limitation: the single-center study and Small sample size. A short time of follow-up to determine whether or not the condition has returned. It did not discriminate the results between acute and chronic diaphragmatic hernia or between blunt and penetrating injuries, or between the evaluation between abdominal approach in acute and chronic diaphragmatic hernia which is another study drawback.

Competing interests

The authors declare that they have no competing financial or non-financial interests.

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Ethical declaration

Medical Ethical Committee at Zagazig University gave us all the ethical agreements. All involved persons gave their informed written consent for publication. All of the authors contributed to the conception and design of the study, the gathering of data, the analysis and interpretation of that data, the drafting of the article or revising it critically to ensure that it contains important intellectual content, and the final approval of the version that will be submitted. The described work has been carried out for human experiments following

the World Medical Association's Code of Ethics (Helsinki Declaration), followed STROBE criteria, and registered in the clinical trial.

REFERENCES

1. Gao J, Du D, Li H, Liu C, Liang S, Xiao Q, et al. Traumatic diaphragmatic rupture with combined thoracoabdominal injuries: Difference between penetrating and blunt injuries. Chinese Journal of Traumatology. 2015; 18(1):21–6.
2. Lewis JD, Starnes SL, Pandalai PK, Huffman LC, Bulcao CF, Pritts TA, et al. Traumatic diaphragmatic injury: experience from a level I trauma center. Surgery. 2009;146(4):578-83; discussion 583-4.
3. Petrone P, Asensio JA, Marini CP. Diaphragmatic injuries and post-traumatic diaphragmatic hernias. Curr Probl Surg. 2017;54(1): 11-32.
4. Payne JH, Yellin AE. Traumatic diaphragmatic hernia. Arch Surg 1982;117:18-24.
5. Baldwin M, Dagens A, Sgromo B. Laparoscopic management of a delayed traumatic diaphragmatic rupture complicated by bowel strangulation. J Surg Case Rep. 2014;2014(7):rju073.
6. Fiscon V, Portale G, Migliorini G, Frigo F. Laparoscopic repair of intrathoracic liver herniation after traumatic rupture of the diaphragm. Surg Endosc. 2011;25(10):3423-5.
7. Blitz M, Louie BE. Chronic traumatic diaphragmatic hernia. Thorac Surg Clin. 2009;19(4):491–500.
8. Hanna WC, Ferri LE, Fata P, Razek T, Mulder DS. The current status of traumatic diaphragmatic injury: lessons learned from 105 patients over 13 years. Ann Thorac Surg. 2008;85(3):1044–8.
9. Desir A, Ghaye B. CT of blunt diaphragmatic rupture. Radiographics. 2012;32(2):477-98.
10. Baker SP, O'Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. 1974;14:187-96.
11. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg. 2009;250 (2):187-196.
12. Blitz M, Louie BE. Chronic traumatic diaphragmatic hernia. Thorac Surg Clin. 2009;19(4):491-500.
13. Turhan K, Makay O, Cakan A, Samancilar O, Firat O, Icoz G, et al. Traumatic diaphragmatic rupture: look to see. Eur J Cardiothorac Surg. 2008;33(6):1082-5.
14. Silva GP, Cataneo DC, Cataneo AJM. Thoracotomy compared to laparotomy in the traumatic diaphragmatic hernia. Systematic review and proportional methanalysis. Acta Cir Bras. 2018; 33(1):49-66.
15. Balaguera JC, García-Almenta MM, Segovia JC, Aquiriano LA, de Tórres SODelgado, Gamarra LP, et al. Delayed Asymptomatic Left Traumatic Diaphragmatic Hernia after Abdominal Stab Wounds. Internet J Surg. 2008;17(2):12-16.
16. Haciibrahimoglu G, Solak O, Olcmen A, Bedirhan MA, Solmazer N, Gurses A. Management of traumatic diaphragmatic rupture. Surg Today. 2004;34(2):111-4.
17. Sánchez-Lozada R, Ortiz-González J, Chavaje GRV. Estrangulación gástrica secundaria a hernia diafragmática traumática. Presentación de un caso. Rev Med Hosp Gen Mex. 2001;64(3):162-166.
18. Mirvis SE, Shanmuganagthan K. Imaging hemidiaphragmatic injury. Eur Radiol. 2007;17(6):1411–21.
19. Iochum S, Ludig T, Walter F, Sebbag H, Grosdidier G, Blum AG. Imaging of diaphragmatic injury: a diagnostic challenge? Radiographics. 2002;22:103-18.
20. Sliker CW. Imaging of diaphragm injuries. Radiol Clin North Am. 2006;44:199–211.
21. Ueno K, Murota Y, Takeda M, Katayama A, Tanaka K. Delayed traumatic diaphragmatic hernia with strangulated stomach; report of a case. Kyobu Geka. 2008;61(5):423-6.
22. Matsevych OY. Blunt diaphragmatic rupture: four year's experience. Hernia. 2008;12(1):73-8.
23. Tiberio GA, Portolani N, Coniglio A, Baiocchi GL, Vettoretto N, Giulini SM. Traumatic lesions of the diaphragm. Our experience in 33 cases and review of the literature. Acta Chir Belg. 2005;105:82-8.
24. Chen HW, Wong YC, Wang LJ, Fu CJ, Fang JF, Lin BC. Computed tomography in left-sided and right-sided blunt diaphragmatic rupture: Experience with 43 patients. Clin Radiol. 2010;65:206-12.
25. Mihos P, Potaris K, Gakidis J, Paraskevopoulos J, Varvatsoulis P, Gougoutas B, et al. Traumatic rupture of the diaphragm: Experience with 65 patients. Injury. 2003;34:169-72.
26. Esme H, Solak O, Sahin DA, Sezer M. Blunt and penetrating traumatic ruptures of the diaphragm. Thorac Cardiovasc Surg 2006; 54(5):324-7.