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The detection and treatment of penetrating diaphragmatic injuries by video-assisted thoracoscopic surgery

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ABSTRACT— Many studies have revealed that it might be challenging to identify diaphragm injuries after penetrating chest trauma. In order to diagnose and treat diaphragmatic injuries following penetrating thoracic traumas, this study would assess the effectiveness of video-assisted thoracoscopic surgery. We conducted a retrospective evaluation of 53 patients who underwent VATS procedures in our department between January 2017 and August 2021 among 617 patients who had penetrating thoracic trauma because there was a possibility of diaphragmatic damage. 43 (81.1%) patients were male, and 10 (18.9%) patients were female with a mean age of 28.74±11.9 years (18- 65 years). In 24 (45.3%) patients, VATS was performed on the left side and the others on the left side according to the penetrating area of trauma. In 36 (67.9%) patients, diaphragmatic laceration was detected and was repaired. The missed injury rate was 20.7%. There was no significant statistical difference between etiology of penetrating trauma, ages and gender of patients ($p>0.05$). No complication was detected during the mean follow up period of 13.57±9.9 (range of 3-6) months. According to our perspective, VATS is crucial and possible in hemodynamically stable individuals who may have an acute diaphragmatic injury following penetrating thoracic trauma but who cannot be diagnosed clinically.

KEYWORDS: penetrating injuries, diaphragm, thoracic traumas, Nasiriyah, Iraq, thoracoscopic surgery.

1. INTRODUCTION

For those under the age of 45, trauma is the main cause of death [1], [2]. 20–25% of all injuries worldwide involve the thorax [3]. 25–50% of posttraumatic mortality is caused by thoracic trauma [4]. A significant number of fatalities that occur minutes or hours after the injury can be prevented by prompt trauma diagnosis and treatment [5], [6]. Thoracic injuries can be roughly divided into blunt and penetrating injuries [7]. The first evaluation of a trauma patient is built on advanced trauma life support (ATLS) procedures [8]. During the primary survey, the patient's airway, breathing, and circulation (ABCs) are typically assessed in that order [9]. Similar initial assessments are conducted on patients who have suffered blunt or penetrating thoracic trauma, with the goal of quickly identifying conditions that pose an immediate threat to life, such as tension pneumothorax, cardiac tamponade, aortic injury, massive hemothorax, and tracheobronchial disruption [10], [11].

Traumatic diaphragmatic injuries are still challenging to diagnose [12]. Small diaphragmatic tears that are left untreated can lead to serious health problems, such as the herniation, obstruction, or strangulation of the abdominal organs to the thorax as a result of the negative pressure in the intervening space [13]. The purpose of this study was to evaluate the effectiveness of video-assisted thoracoscopic surgery (VATS) in the identification and treatment of diaphragmatic trauma in patients with hemodynamically stable thoracic injuries after penetrating trauma.

2. Materials and methods

Among the 617 thoracic trauma patients admitted to the Nasiriyah Heart Center in Nasiriyah, Iraq, between January 2017 and August 2021, we retrospectively evaluated a total of 53 patients who underwent VATS due to probable localization of diaphragmatic injury in our department. The following criteria were used to choose patients for VATS: stable or normal hemodynamic status, capacity for single lung breathing, and ability to maintain lateral decubitus posture. Entry wounds that are inferior to the nipple line or lower angle of the scapula should be evaluated for diaphragmatic damage.

The data on the characteristics of the injuries was gathered from the victims or their family members as well as from their case records. Age, gender, method of injury, hemodynamic state at time of arrival and the existence of concomitant injuries are the variables considered in this study.

Under constant staff supervision, a senior surgical resident carried out all operations in the operating room while the patient was under general anesthesia. A double-lumen endotracheal tube was placed as part of the VATS procedure to manage the airway and maximize exposure with one-lung breathing following the collapse of the ipsilateral lung. VATS was performed with 3-port access and 30° scope that allowed an excellent visualization of the diaphragm. Inhalational anesthetics were administered to help them work better and short-acting intravenous anesthetics were utilized to make extubation easier once the treatment was over.

The Statically Package for the Social Science software was used to do statistical analysis (SPSS, 25). The data were presented as mean±SD. For categorical measurements, frequencies and percentages were utilized. The statistical analysis for the differences in penetrating trauma types, ages, and gender of patients used Student's t and chi-square tests. $P<0.05$ were considered statistically significant.

3. Results

This research includes fifty-three cases of suspected diaphragmatic injury. The mean age was 28.74±11.9 years (range, 18- 65 years). Of the 53 patients, 43 (81.1%) were men 10 (18.9%) patients were female. Stab wounds were present in 39 patients (73.5%), gunshot wounds in 11 patients (20.7%), and other causes in 3 patients (5.8%). There was no significant statistical difference between etiology of penetrating trauma, ages and gender of patients ($p>0.05$).

According to penetrating the traumatized area, VATS was done on the left side of 24 patients (45.3%), of whom 15 had anterior and 12 had posterior hemithorax locations, and on the right side of 21 patients (39.6%). (10 of them anterior, 8 of them posterior hemithorax located); However, lateral injuries, present in only 8 patients (15.2%). The findings at the time of VATS are described in Table 1. The diaphragmatic injury was detected in 11 patients without any radiological images being found. The missed injury rate was 20.7%. Of them, 28 (77.8%) cases caused an injury to the left side of the diaphragm.

A tube thoracostomy was done on patients with 10 pneumothoraxes, 14 Hemothorax, and 4 hemopneumothoraxes while conservative therapy was given to 19 patients with pulmonary contusions.

Table 1 Penetrating thoracic injury in 53 patients.

VATS findings	Number of patients	percentage (%)
Diaphragmatic injury	36	67.9

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Pleural penetration	37	69.8
Pulmonary contusion	19	35.8
Hemothorax	13	24.5
Pneumothorax	9	17
Lung laceration	11	20.8
Pericardial laceration	6	11.3
Hemopneumothorax	3	5.7

None of the patients experienced any complications related to the VATS surgery or the anesthetic medication; neither an open thoracotomy conversion nor intraoperative issues were seen. No intraoperative or postoperative mortality was noted. The mean length of hospital stay was 2.6±0.7 (2–5) days. However, six postoperative complications (11.3%) were documented. These complications included postoperative pain in four patients and two wound infections in old chest tube sites. The wound infections were managed successfully with broad-spectrum i.v. antibiotics and daily dressing.

The mean follow-up duration was 13.57±9.9 months, with a range of 3-6 months. Pulmonary function tests and chest X-rays were carried out during this follow-up period. Clinical improvements, recovery, and complications were assessed. Neither traumatic pathology nor a diaphragmatic hernia were found in any patient throughout the follow-up.

4. Discussion

In 73.5% of patients in the current study, stab wounds were the most common penetrating injuries, which is consistent with research conducted in the UK by [14]. In this study, 77.8% of diaphragmatic lacerations occurred on the left hemithorax, confirming previous finding that the left hemidiaphragm was more frequently injured; as the right diaphragm is well-protected by the liver [15]. The incidence of diaphragmatic injuries in our study was 67.9% in penetrating thoracoabdominal trauma and this result is in line with a studies conducted by [16- 18].

Diaphragmatic traumas can be categorized into three categories: acute, latent, and late [19]. Within 0-14 days of the accident, acute diaphragmatic damage is discovered. Diagnosis of latent diaphragmatic damage occurs after acute injury but before intestinal blockage or strangulation. Strangulation or intestinal blockage are used to detect late diaphragmatic damage. Small diaphragmatic lacerations are difficult to diagnose [20]. Within 48 hours, probing VATS was used to analyze each of the patients of the current study and this in consistence with a study done by [21].

Diaphragmatic lacerations do not heal spontaneously because the diaphragm is a thin muscle; a differential pressure gradient between the pleural space and the peritoneal cavity facilitates the migration of abdominal contents into the thoracic cavity; the constant movement of the diaphragm delays healing; and this may cause rapid necrosis, sepsis, and unexpected death in undiagnosed cases [22], [23]. So, it can be attributed to those points that exploratory VATS is very important in every suspected case of penetrating trauma.

The diagnosis of diaphragm injury can be difficult for trauma surgeons. Using many non-invasive methods,

including physical examination, chest X-ray, computed tomography, magnetic resonance imaging. Some of these tests can miss diaphragmatic injuries, and there is overwhelming evidence that missed diaphragmatic injuries may have significant consequences [24], [25]. In our study, the hidden injury rate was 20.7%, which is in line with a study done by [26] in the US in 2020.

In our study, non-absorbable (0 or 1) sutures were used for primary repair, which is consistent with a study done by [27]. However, the repair should be supported by prosthetic meshes to strengthen the diaphragm in large defects or chronic cases [28].

This study highlighted that the indications for VATS are both diagnostic and therapeutic and include mainly the evaluation of a structural injury (the diaphragm, the pericardium, the lung parenchyma, the thoracic duct, etc.) or the drainage of a pleural collection and repair of any structural damage [29]. Aside from the usual bleeding disorders, the main contraindications of VATS include an unstable patient, or a patient with underlying lung and cardiac [30].

5. Conclusion

We conclude that in terms of clinical and radiological examination, the identification of diaphragmatic injuries resulting from penetrating thoracic trauma is challenging. This may lead to complications. Hidden injuries may cause severe consequences. When imaging techniques are ineffective in diagnosing penetrating chest injuries, VATS should be used for diagnosis and treatment.

6. Reference

[1] Miclau T. Understanding trauma systems: A global need. OTA International. 2019 Mar 1;2(S1):e010.

[2] Heron M. Deaths: Leading Causes for 2015. National vital statistics reports: from the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System. 2017 Nov;66(5):1-76.

[3] Beshay M, Mertzlufft F, Kottkamp HW, Reymond M, Schmid RA, Branscheid D, et al. Analysis of risk factors in thoracic trauma patients with a comparison of a modern trauma centre: a mono-centre study. World journal of emergency surgery. 2020 Dec;15(1):1-0.

[4] Fokkema AT, Johannesdottir BK, Wendt K, Haaverstad R, Reininga IH, Geisner T. Comorbidities, injury severity and complications predict mortality in thoracic trauma. European journal of trauma and emergency surgery. 2022 Dec 17:1-3.

[5] Babu SV. The Golden Hour Trauma Care. Indian Journal of Neurotrauma. 2021 Feb 22.

[6] Planas JH, Waseem M, Sigmon DF. Trauma Primary Survey. StatPearls [Internet]. 2022 Jan.

[7] Woolley TG, Dick S, Reid D. Mechanism of Injury. InTextbook of Acute Trauma Care 2022 (pp. 421-433). Springer, Cham.

[8] Gandham S, Annis P. The principles of the advanced trauma life support (ATLS) framework in spinal trauma. Orthopaedics and Trauma. 2020 Oct 1;34(5):305-14.

[9] Ruggero JM, Martin MJ. Difficult Decisions in Trauma: Is ABC the Right Mantra?. InDifficult Decisions in Trauma Surgery 2022 (pp. 3-11). Springer, Cham.

[10] Jahn HK, Nwomeh BC. Thoracic Trauma. InPediatric Surgery 2020 (pp. 303-314). Springer, Cham.

[11] Lodhia JV, Eyre L, Smith M, Toth L, Troxler M, Milton RS. Management of thoracic trauma. Anaesthesia. 2022 Dec 26.

[12] Kwon J, Lee JC, Moon J. Diagnostic significance of diaphragmatic height index in traumatic diaphragmatic rupture. Annals of Surgical Treatment and Research. 2019 Jul 1;97(1):36-40.

[13] Kumar A, Gamanagatti S. Imaging in thoracic trauma. Diagnostic Radiology: Chest and Cardiovascular Imaging. 2018 Mar 31:291.

[14] Pollock GA, Lo J, Chou H, Kissen MS, Kim M, Zhang V, Betz A, Perlman R. Advanced diagnostic and therapeutic techniques for anaesthetists in thoracic trauma: an evidence-based review. British Journal of Anaesthesia. 2022 Aug 26.

[15] El Saied AM. Diaphragmatic Surgeries: A Single Center Experience in 10 years. The Egyptian Journal of Hospital Medicine. 2022 Oct 1;89(2):7400-2.

[16] McDonald AA, Robinson BRH, Alarcon L, Bosarge PL, Dorion H, Haut ER, et al. Evaluation and management of traumatic diaphragmatic injuries: A Practice Management Guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2018 Jul;85(1):198-207.

[17] Cardoso LF, Gonçalves MV, Machado CJ, Resende V, Fernandes MP, Pastore-Neto M, et al. Retrospective analysis of 103 diaphragmatic injuries in patients operated in a trauma center. Revista do Colégio Brasileiro de Cirurgiões. 2017 May;44:245-51.

[18] Yanık F, Karamustafaoğlu YA, Yörük Y. The role of VATS in the diagnosis and treatment of diaphragmatic injuries after penetrating thoracic traumas. Turkish Journal of Trauma and Emergency Surgery. 2020 May 1;26(3):469-74.

[19] Okyere I, Mensah S, Singh S, Okyere P, Kyei I, Brenu SG. Surgical management of traumatic diaphragmatic rupture: ten-year experience in a Teaching Hospital in Ghana. Kardiochirurgia i Torakochirurgia Polska/Polish Journal of Thoracic and Cardiovascular Surgery. 2022 Mar 24;19(1):28-35.

[20] Abdellatif W, Chow B, Hamid S, Khorshed D, Khosa F, Nicolaou S, Murray N. Unravelling the mysteries of traumatic diaphragmatic injury: an up-to-date review. Canadian Association of Radiologists Journal. 2020 Aug;71(3):313-21.

[21] Zeiler J, Idell S, Norwood S, Cook A. Hemothorax: A Review of the Literature. Clin Pulm Med. 2020 Jan;27(1):1-12.

[22] Rambau M, Bhuiyan MM. Missed traumatic diaphragmatic hernia and literature review. South African Medical Journal. 2021 Dec 1;111(11b):1152-4.

[23] Yazbek BO, Abreu P, Bettega AL, Khan ZF, Marttos A. Diaphragmatic Trauma. InThe Trauma Golden Hour 2020 (pp. 107-112). Springer, Cham.

[24] Yahyoev SO, Khodzhimatov GM. Diagnostic methods and surgical treatment of patients with thoracoabdominal traumas (review of the literature). Kardiochirurgia i Torakochirurgia Polska/Polish Journal of Thoracic and Cardiovascular Surgery. 2022;19(4):226-31.

[25] Nancy Denke DN. Catch Me If You Can: Missed Injuries in Trauma.

[26] Shaban Y, Elkbuli A, McKenney M, Boneva D. Traumatic Diaphragmatic Rupture with Transthoracic Organ Herniation: A Case Report and Review of Literature. Am J Case Rep. 2020 Jan 3;21:e919442.

[27] Furák J, Athanassiadi K. Diaphragm and transdiaphragmatic injuries. J Thorac Dis. 2019 Feb;11(Suppl 2):S152-S157.

[28] DeBarros M, Martin MJ. Penetrating traumatic diaphragm injuries. Current Trauma Reports. 2015 Jun;1(2):92-101.

[29] Schreyer C, Eckermann C, Neudecker J, Becker L, Schulz-Drost S. VATS in Thorax Trauma. Zentralblatt fur Chirurgie. 2022 Dec 5.

[30] Singh S, Sinha CK, Davenport M. Thoracic Trauma. InHandbook of Pediatric Surgery 2022 (pp. 87-97). Springer, Cham.