

Is diagnostic laparoscopy necessary in the management of left thoracoabdominal stab wounds?

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ABSTRACT

BACKGROUND: The diagnosis of a diaphragmatic rupture and the identification of patients for surgical repair is challenging despite current diagnostic algorithms and imaging technologies. Unless treated on time, acute traumatic diaphragmatic injury due to stab wounds has a high mortality and morbidity rate, with an increasing trend in the presence of organ herniation. In this study, we aimed to investigate the efficacy of diagnostic laparoscopy in patients with an anterior thoracoabdominal stab wound and to compare the follow-up outcomes of cases.

METHODS: We retrospectively reviewed our institutional database of patients who were admitted with stab wounds between October 2012 and 2022. Patients who underwent diagnostic laparoscopy were divided into two groups depending on the presence of a diaphragmatic injury. We analyzed demographics, the success of computed tomography (CT) imaging in the diagnosis, the presence of hemomediastinum, pneumomediastinum, tube thoracostomy application, associated organ injury, type of surgery, duration of surgery, complications, and the length of stay between the groups.

RESULTS: Of the 39 patients with penetrating left thoracoabdominal injury underwent diagnostic laparoscopy, CT had a diagnostic sensitivity of 63.16% (95% Confidence interval [CI] 38.36–83.71%), and a specificity of 100% (95% CI 82.35–100.00%). We could not find a statistically significant difference between the groups in terms of studied variables, while operation time was significantly higher in the diaphragmatic injury group ($P<0.01$). Fourteen patients had accompanied visceral injuries.

CONCLUSION: Diagnostic laparoscopy is still the gold standard particularly in the ER setting, particularly in the absence of an experienced radiologist for 24 h and when the close monitoring of the patient by the same team cannot be provided.

Keywords: Computed tomography; diagnostic laparoscopy; left thoracoabdominal stab wounds.

INTRODUCTION

The diagnosis of a diaphragmatic rupture is difficult in patients without unstable hemodynamics and symptoms such as abdominal pain, peritonitis, shock, and evisceration, which are indications for emergency surgery.^[1] An early diagnosis of acute traumatic diaphragmatic injury due to stab wounds is crucial for the prevention of life-threatening complications.

Imaging diagnosis of the acute traumatic diaphragmatic injury is challenging with a low sensitivity despite the recent ad-

vances in imaging, and a missed diagnosis of any diaphragmatic injury in the absence of organ herniation into the chest cavity has a mortality rate of 50%.^[2]

Since its introduction by Shaftan in the 60s, selective non-operative management has become the standard of care for thoracoabdominal stab wounds. Although he reported that, in reality, nearly half of the patients who underwent a diagnostic laparotomy required the procedure, several reports indicate higher negative laparotomy rates.^[3,4]

Cite this article as: Ökmen H, Ulsan K, Aren A. Is diagnostic laparoscopy necessary in the management of left thoracoabdominal stab wounds? *Ulus Travma Acil Cerrahi Derg* 2023;29:1026-1031.

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Ulus Travma Acil Cerrahi Derg 2023;29(9):1026-1031 DOI: 10.14744/tjtes.2023.33423 Submitted: 10.04.2023 Revised: 25.07.2023 Accepted: 02.08.2023
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However, a diagnostic laparoscopy has been advocated as the primary approach for a definite surgical exploration of patients with penetrating trauma, due to the reports noting that, in 85% of cases, the diaphragmatic defect is minor with a size smaller than 2 cm and asymptomatic.^[5]

Despite the high incidence of negative laparotomy cases which brings an extra burden to health services and leads to several complications including intestinal adhesion, obstruction, and wound site infections, delayed treatment of visceral injuries is a potential risk factor for increased mortality and morbidity in asymptomatic patients.

Alongside the cases with negative outcomes, discomfort, and the reluctance of patients for a diagnostic laparotomy, there has been an ongoing debate regarding the necessity of the procedure, whereas the 10–50% diaphragmatic injury rate of penetrating stab wounds could not be omitted.^[6,7]

Hence, the aim of this study was to investigate the efficiency of diagnostic laparoscopy in patients with a left thoracoabdominal stab wound and to compare the follow-up outcomes of cases with or without a diaphragmatic injury.

MATERIALS AND METHODS

Ethics

Written informed consent was obtained from each subject following a detailed explanation of the objectives and protocol of the study. The study was approved by the Medical Ethics Committee of our University and was performed in accordance with the Declaration of Helsinki.

Study Design and Patients

In the emergency surgery department, we retrospectively reviewed our institutional database to find patients who were admitted with stab wounds between October 2012 and 2022. The thoracoabdominal region was defined as the region between the sternum, fourth intercostal space, and arcus costa anteriorly and the vertebra, lower tip of the scapula, and the curve of the last rib posteriorly.

Patients without injuries to the thoracoabdominal region were excluded from the study. In our clinic, the cases with left thoracoabdominal stab wounds undergo a diagnostic laparoscopy procedure immediately after the admission. In the context of this study, patients who went through a diagnostic laparoscopy were divided into two groups: Group 1, patients with diaphragmatic injury, and Group 2, patients without diaphragmatic injury. Then, we analyzed demographics, the success of computed tomography (CT) imaging in the diagnosis, presence of hemomediastinum, pneumomediastinum, tube thoracostomy application, associated organ injury, type of surgery, duration of surgery, complications, and the length of stay between the groups.

All patients were evaluated with CT at the time of admission to emergency surgery. The success of CT in the diagnosis of

diaphragmatic rupture was evaluated. The effects of diaphragmatic rupture on surgical difficulty, conversion to open surgery, operation time, complications, and hospital stay were also evaluated.

Statistical Analysis

The Shapiro–Wilk test was used for testing the normality of continuous variables. Baseline pre-operative variables were compared through χ^2 analyses for categorical data or Fisher's exact test, where appropriate. The Mann–Whitney U-test was used to compare the medians of non-parametric variables. The student's t-test was used to compare parametric data between two independent groups, which provided that the distribution of data was normal. In all analyses, $P < 0.05$ was taken to indicate statistical significance. Statistical analyses were performed using SPSS Statistics for Windows (Version 23.0; IBM, Armonk, NY).

RESULTS

Between 2012 and 2022, 4378 trauma patients due to stabblings were admitted to the emergency surgery service. Of them, 39 patients with penetrating left thoracoabdominal injury underwent diagnostic laparoscopy, and the outcomes were analyzed in our study.

There were 37 (94.9%) males and 2 (5.1%) females with a mean age of 29.63 ± 10.28 years (range: 17–62 years).

The comparison data of the patients with or without a diaphragmatic injury that was detected during the diagnostic laparoscopy are summarized in Table 1.

In our cases, CT had a diagnostic sensitivity of 63.16% (95% Confidence interval [CI] 38.36–83.71%), and a specificity of 100% (95% CI 82.35–100.00%), with a 73.1% negative predictive value (95% CI 60.10–83.02%) 81.58% diagnostic accuracy (95% CI 65.67–92.26%).

We could not find a statistically significant difference between the groups in terms of age, length of hospital stay, complications, radiological diagnosis, hemomediastinum/pneumomediastinum, tube thoracostomy application, and conversion rate to open surgery.

Age, hemomediastinum/pneumomediastinum, tube thoracostomy application, and associated organ injury were not evaluated as risk factors for rupture of the diaphragm. Operation time was significantly higher in the diaphragmatic injury group ($P < 0.01$).

A total of 11 patients required conversion to open repair. We did not have patients who underwent a non-therapeutic laparotomy procedure.

The group of patients with associated intra-abdominal visceral injuries included 5 splenic, 3 stomach, 3 large bowel, 1 hepatic, 1 mesenteric, and 1 kidney injury which was managed successfully by either laparoscopy or open repair (Table 2).

Table 1. Patient demographics and clinical data

	Patients with diaphragmatic injury (n=19)	Patients without diaphragmatic injury (n=19)	
Gender (M/F)	19/0	17/2	0.48
Age (years)	28.05±7.44	31.21±12.51	0.35
Operation time (#)			
30–60 min	2	10	
60–90 min	10	5	<0.01
90–120 min	6	2	
120–150 min	1	1	
150–180 min	0	1	
Length of hospital stay (days)	5.52 ±2.59	4.89±2.78	0.47
Complications (Yes/No)	1/18	0/19	0.99
Radiological diagnosis			
None	7	19	
CT	12	0	<0.0001
Pre-operative hemopneumomediastinum			
Yes	6	5	
No	13	14	0.67
Surgery			
Emergency	10	11	
Elective	9	8	0.96
Thoracostomy			
No	8	13	
Pre-operative	5	4	
Intraoperative	6	2	0.25
Conversion to open surgery			
Yes	7	4	
No	12	15	0.36

Table 2. Associated intra-abdominal visceral injuries of the patients presented with left thoracoabdominal stab wounds

	Patients with diaphragmatic injury (n=19)	Patients without diaphragmatic injury (n=19)
None	12 (63.2%)	12 (63.2%)
Spleen	3 (15.8%)	2 (10.6%)
Stomach	1 (5.3%)	2 (10.6%)
Large bowel	1 (5.3%)	2 (10.6%)
Liver	1 (5.3%)	0
Mesentery	0	1 (5.3%)
Kidney	1 (5.3%)	0

Seven patients without a diaphragmatic rupture had abdominal organ lacerations and required conversion to laparotomy. These included 2 splenic, 2 stomach, 2 large bowel, and 1 mesentery injury.

Complications included pericarditis and pleural effusion in one patient of the diaphragmatic injury group, and the patient was discharged following 20 days of coronary ICU admission.

DISCUSSION

The diagnosis of an occult traumatic diaphragmatic injury and associated visceral organ injury is a long-time debated factor for the management of left-sided thoracoabdominal trauma patients. The methods of treatment are varied among the trauma centers and the surgeons, while some advocate a close follow-up, and a large group of physicians finds that clinical evaluation is not totally reliable with a low sensitivity for the identification of patients who require surgical repair.^[2,8]

Despite the reported high efficiency of a combined approach of serial physical examinations with laboratory tests and radiological imaging techniques, reports also verify the presence of missed serious injuries and organ lacerations.^[9,10] Although selective non-operative management would ameliorate the negative laparotomy rates in the presence of hemodynamic stability, findings of the laboratory and imaging investigations might still fail to identify the minor injuries of the diaphragm. The diagnostic modalities available other than serial physical examination and observation for abdominal stab wounds include diagnostic peritoneal lavage, local wound exploration, ultrasonography, and CT to minimize the risk of missed injuries.^[11]

Particularly in the presence of an integrated diaphragm, the consequences and outcomes of a missed organ injury possess a high risk of mortality and morbidity. Hence, a diagnostic laparoscopy is suggested as a minimally invasive method for the evaluation of patients with penetrating injuries.^[12,13]

In our study, we evaluated trauma patients with penetrating left thoracoabdominal injury who underwent diagnostic laparoscopy and compared the outcomes between patients with or without a diaphragmatic injury. We observed that the two groups did not show a difference in terms of radiological diagnosis, hemomediastinum/pneumomediastinum, tube thoracostomy application, conversion rate to open surgery, length of hospital stay, and complications.

The sensitivity of modern radiological scanning techniques in detecting diaphragmatic defects varies from 36% to 83%, whereas the ratio in our study group was between the limits.^[14,15]

Yucel et al. monitored stable cases for 48 h and compared the findings of diagnostic laparoscopy retrospectively with the CT images obtained during the admission. They found that the multislice tomography had a sensitivity and specificity of 82% and 88%, respectively.^[7] Thus, our 63.2% ratio of diagnostic sensitivity for our cases was relatively lower, whereas we defined a 100% of positive predictive value. First, most of the cases presented with thoracoabdominal stab wounds apply to the ER at night times, while CT scanings are read by the resident radiologists and the positive findings of diaphragmatic injury might be missed. Second, since respiratory and motion artifacts limit the visualization, an imaging acquisition protocol for the CT scans might be needed to provide multiplanar

reconstructions that would enable a better evaluation of the images.

Despite the debate regarding the necessity of a diagnostic laparoscopy procedure for asymptomatic cases, the incidence of occult left-side diaphragmatic injury varies between 17 and 38%.^[13] Another report from a first-level trauma center showed a 42–47% incidence of diaphragmatic injury on the left side penetrating injury, similar to our rates.^[12]

It was determined that sex, age, hemomediastinum, pneumomediastinum, tube thoracostomy application, and associated organ injury were risk factors for diaphragmatic rupture. The ratio of patients with a pre-operative hemopneumomediastinum was similar between the groups in our series, and 45% required a thoracostomy during the pre- or intraoperative period.^[16-18]

Most diaphragmatic injuries involve the left diaphragm, since right-side diaphragmatic injuries are relatively rare, given the protective effect of the liver. However, due to the lack of a standardized approach to these injuries, some cases might be overlooked which may provide altered statistical proportions.

Some centers embrace a 24–48-h observation protocol for this type of injury due to the interference of enteric contents in the diagnosis of peritonitis and other related symptoms.^[11] A rapid intervention before the herniation of visceral organs into the chest cavity and the patient becoming symptomatic might also serve as an underlying factor for the false negative cases. However, urgent care should be taken before the incident, since the mortality might be as high as 80% in case of strangulation of the herniated viscera.^[19] A diagnostic laparoscopy also aids in the diagnosis of hollow visceral injuries, while we found a 37% ratio of visceral injury comprising the spleen, stomach, large bowel, and mesentery.

Diaphragmatic rupture increases conversion to open surgery, operation duration, complication rate, and hospital stay in the literature.^[20] However, in our study, we did not find a significant difference between the two groups, whereas the duration of operating time was significantly higher in the diaphragmatic injury group.

In some cases with omentum evisceration, laparotomy might be avoided and serial clinical examination is suggested. Furthermore, the Western Trauma Association critical decisions algorithm recommends that patients without hemodynamic instability, peritonitis, impalement, evisceration, and gross blood from a nasogastric tube or on rectal examination should be evaluated for peritoneal penetration using tools such as focused assessment with ultrasonography for trauma (FAST) and local wound exploration.^[21] Due to the variations in the management of left thoracoabdominal stab wounds, and the selection of patients for non-operative management, several institutional algorithms were also provided for guidance. Thus, in addition to the recent literature, the experience of the surgeon and the traditional approach of the institution are also important factors when forming a man-

agement protocol for left thoracoabdominal injuries.

A 2-year cross-sectional study to evaluate the diagnostic accuracy of FAST revealed an overall accuracy score of 75%, concluding that approach cannot be a definitive alternative to diagnostic laparoscopy to detect diaphragm rupture.^[22]

Although some advice a follow-up with leukocyte numbers and indices, a recent study showed the insufficiency of these parameters in the detection of asymptomatic diaphragmatic injuries caused by penetrating left thoracoabdominal stab wounds.^[23]

Despite several reports suggesting the non-operative management of stab wounds, most data were derived from exclusively abdominal injuries. They also suggest the observation of the patient by a single surgeon starting from admission to discharge or to the surgery.^[10] However, for the institutions such as ours, being a teaching hospital specializing in all general surgery practices, the timing of the admission plays an important role in the application of the single surgeon approach. In our practice, trauma patients are consulted in the ER by a surgery resident and referred to the general surgery ward or ER for further evaluation. Some stable cases are kept in the ER, and follow-up is performed by the ER physicians, and surgery residents on a rotational basis. Therefore, the case of shift changes might complicate the single surgeon or single team approach.

The limitations of our study include a relatively lower sample size and we did not present the hematological findings of the patients. Moreover, this is a single-center retrospective chart review study which might interfere with the generalizability of our results. However, we focused on a specific type of injury that is relatively rare, and we did not encounter morbidity or mortality in any of our cases.

CONCLUSION

Although follow-up is an accepted management method for hemodynamically stable patients with left thoracoabdominal stab wounds, a diagnostic laparoscopy still remains the gold standard while an experienced radiologist is not present in the ER setting especially in the night shifts, and close monitoring by a single surgeon cannot be managed at all times.

Ethics Committee Approval: This study was approved by the University of Health Sciences Istanbul Training and Research Hospital Research Ethics Committee (Date: 07.04.2023, Decision No: 98).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: H.Ö., K.U., A.A.; Design: H.Ö., K.U., A.A.; Supervision: H.Ö., K.U., A.A.; Resource: H.Ö., K.U., A.A.; Materials: H.Ö., K.U., A.A.; Data collection and/or processing: H.Ö., K.U., A.A.; Analysis and/or interpretation: H.Ö., K.U., A.A.; Literature search: H.Ö., K.U., A.A.; Writing: H.Ö., K.U., AA; Critical review: H.Ö., K.U., A.A.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

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ORİJİNAL ÇALIŞMA - ÖZ

Sol torakoabdominal bıçak yaralarının tedavisinde tanısal laparoskopi gerekli midir?

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AMAÇ: Diyafram rüptürünün tanısı ve cerrahi tedavi gerektiren hastaların ayırt edilebilmesi, mevcut teşhis algoritmalarına ve ileri görüntüleme tekniklerinin varlığına rağmen halen güçtür. Zamanında tedavi edilmediğinde, kesici/delici alet yaralanmalarına bağlı akut travmatik diyafragma hasarı, organ herniasyonu mevcudiyetinde artan bir eğilimle birlikte, yüksek bir mortalite ve morbidite oranına sahiptir. Bu çalışmada, anterior torakoabdominal bıçak yarası olan hastalarda tanısal laparoskopinin etkinliğini araştırmayı ve olguların takip sonuçlarını karşılaştırmayı amaçladık.

GEREÇ VE YÖNTEM: Ekim 2012-2022 arasında kesici/delici alet yaralanması ile başvuran hastaların yer aldığı kurumsal veri tabanımızı retrospektif olarak inceledik. Tanısal laparoskopi uygulanan hastalar diyafragma yaralanması varlığına göre iki gruba ayrıldı. Demografik veriler, bilgisayarlı tomografi (BT) görüntülemenin tanıdaki başarısı, hemomediastinum, pnömomediasten varlığı, tüp torakostomi uygulaması, eşlik eden organ yaralanması, cerrahi tipi, cerrahi süresi, komplikasyonları ve hastanede kalış süreleri, gruplar arasında karşılaştırıldı.

BULGULAR: Penetran sol torakoabdominal yaralanması olan 39 hastaya tanısal laparoskopi yapıldı, BT'nin tanısal duyarlılığı %63.16 (%95 GA %38.36 ila %83.71) ve özgüllüğü %100 (%95 GA %82.35 ila %100.00) idi. Analiz edilen değişkenler açısından gruplar arasında istatistiksel olarak anlamlı bir fark bulunamazken, ameliyat süresi diyafragma hasarı bulunan grupta anlamlı olarak daha uzun saptandı ($p<0.01$). On dört hastada eşlik eden visseral organ yaralanmaları mevcuttu.

SONUÇ: Tanısal laparoskopi, acil serviste, özellikle tecrübeli bir radyoloğun 24 saat bulunamaması durumunda ve hastanın aynı ekip tarafından yakın takibinin sağlanmadığı durumlarda altın standart bir tanı yöntemi olma özelliğini halen korumaktadır

Anahtar sözcükler: Tanısal laparoskopi, sol torakoabdominal kesici alet yaralanması, bilgisayarlı tomografi.

Ulus Travma Acil Cerrahi Derg 2023;29(9):1026-1031 DOI: 10.14744/tjtes.2023.33423