

Prevalence of thoracic and abdominal injuries in patients with penetrating thoracoabdominal trauma

Prevalencia de lesiones torácicas y abdominales en pacientes con traumatismo toracoabdominal penetrante

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Abstract

Objective: To establish the prevalence of diaphragmatic, thoracic and abdominal injuries associated with penetrating thoracoabdominal trauma. **Method:** Retrospective chart review of all admitted patients with penetrating thoracoabdominal trauma who required surgical management at the University Hospital of Santander during a 12-month period. A descriptive analysis of the findings using measures of central tendency and dispersion for quantitative variables and proportions with confidence intervals for qualitative variables was made. **Results:** Of the 112 patients included, 91.3% were admitted with injuries from sharp weapons, 60% of the wounds were on the left and 66% were below the 8th intercostal space. Some type of organ damage was reported in 34% of the patients and 27.6% had a diaphragmatic injury. The most frequently intraabdominal injured organ was liver (9.8%), followed by spleen (6.25%) and colon (6.25%). **Discussion and conclusions:** The most frequently affected thoracoabdominal area was the posterior left, however, the highest prevalence of diaphragmatic injury was found in the anterior left area. The risk of diaphragmatic injury in the anterior left area was 10 times greater than in the posterior right area and almost doubled the risk of the posterior left region. There was no statistically significant difference between the anterior left area and the anterior right area. Solid viscus injuries are most common in the abdominal cavity.

Keywords: Penetrating trauma. Thoracoabdominal area. Diaphragm. Thoracoabdominal injuries.

Resumen

Objetivo: Establecer la prevalencia de lesiones diafrágicas, torácicas y abdominales asociadas con traumatismos toracoabdominales penetrantes. **Método:** En un período de 12 meses se recopiló los pacientes que ingresaron a un hospital de tercer nivel de complejidad con traumatismo toracoabdominal penetrante y que requirieron manejo quirúrgico. Se realizó un análisis descriptivo de los hallazgos empleando medidas de tendencia central y dispersión para las variables cuantitativas y proporciones con intervalos de confianza para las variables cualitativas. **Resultados:** Se incluyeron 112 pacientes, de los cuales el 91.3% ingresó con heridas por arma blanca, el 60% de las heridas se encontraban del lado izquierdo y en el 66% de los casos debajo del octavo espacio intercostal. El 34% de los pacientes presentaban algún tipo de lesión orgánica y el 27.6% lesión diafrágica. El órgano intraabdominal con más frecuencia lesionado fue el hígado (9.8%), seguido del bazo (6.25%) y el colon (6.25%). **Discusión y conclusiones:** La zona toracoabdominal más a menudo afectada fue la posterior izquierda, pero la de mayor prevalencia de lesión diafrágica fue la anterior izquierda, siendo el riesgo de lesión diafrágica

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en esta zona 10 veces mayor en comparación con la zona posterior derecha y casi el doble con respecto a la región posterior izquierda; no se encontró diferencia estadísticamente significativa al compararlo con la región anterior derecha. Las lesiones de víscera sólida son las más frecuentes en la cavidad abdominal.

Palabras clave: Trauma penetrante. Área toracoabdominal. Diafragma. Lesiones toracoabdominales.

Introduction

The incidence of diaphragmatic injuries caused by penetrating thoracoabdominal trauma is between 37% and 50%, depending on the injury mechanism¹⁻³. Between 25% and 48% of patients with diaphragmatic injury have normal physical exploration or non-specific symptoms, such as pleuritic or abdominal pain, making diagnosis and therapy a challenge; however, in some cases, there could be symptoms ranging from hemodynamic instability⁴ to bowel obstruction and respiratory insufficiency weeks or months after the initial injury if not corrected⁵. Penetrating trauma is usually accompanied by small diaphragmatic injuries that can gradually increase in diameters, facilitating late herniation; closed trauma, on the other hand, usually generates large defects, between 5 and 15 cm⁶. Multiple injuries associated with diaphragmatic rupture have been described in 88.5% of cases, and the lungs are the most commonly affected organ (46.5%), followed by cardiac injuries (11.6%), liver injuries (11.6%), spleen injuries (6.9%), and hollow viscera injuries (4.6%)⁷. The potential compromise of two cavities (thorax and abdomen) makes it difficult to identify the trajectory of the injury, and there are no completely reliable radiology tools for diagnosis. Thorax x-rays have a rate of false negative of up to 50%⁸, and computerized tomographies have a sensitivity of 82% and a specificity of 88%^{9,10}. For this reason, surgical procedures for diagnosis or therapy (or both) that are open or minimally invasive and with thoracic or abdominal approaches, have been used. The use of laparotomies complementing an initial thoracic procedure is frequent, and it is linked to an increase of mortality in patients^{11,12}.

Few other topics in surgery have generated as much controversy as thoracoabdominal trauma, and there are no recent statistics in our field; therefore, the purpose of this study was to establish the prevalence of diaphragm, thorax, and abdominal injuries associated with a penetrating thoracoabdominal trauma.

Method

Cross-sectional observational study including all patients over 12 years of age who were admitted into

the ER in a hospital with third level of complexity in Colombia, between August 2017 and August 2018, with penetrating thoracoabdominal trauma diagnosis, and who required emergency surgical management. The thoracoabdominal area was defined as the region between a horizontal line crossing the fifth intercostal space, continuing as a horizontal line that crosses the seventh intercostal space, with the costal edge as the lower limit. The limit between the anterior and posterior thoracoabdominal area was drawn by the posterior axillary lines.

Demographical and clinical data were collected by reviewing electronic clinical histories using a format created for this purpose. The information was entered twice, validated, and exported in .dta format to be analyzed in Stata®11.0. A descriptive analysis of the findings of the survey was performed with central tendency and dispersion for quantitative variables and with proportions and confidence intervals of 95% for qualitative variables. A bivariate analysis was performed calculating relative prevalences as a measure of association. Finally, factors that, in the bivariate analysis, were found to be associated with organ injuries were taken to a stratified analysis, and afterwards, a multivariate analysis was performed using a regression method with the purpose of adjusting the combined effects, and lastly, the adjusted relative prevalences of each attitude detected. Input and output of variables in the regression model was based on the criteria established by Sander Greenland¹³.

This research project followed the principles set in the ICH Good Clinical Practice guidelines and the ethical principles of the Declaration of Helsinki, and approved by the Ethics Review Committee of the Universidad Industrial de Santander.

Results

During the described period, 572 patients with thoracic or abdominal trauma were admitted to the ER. 129 clinical histories of patients with single penetrating thoracoabdominal wounds were analyzed. Patients with multiple wounds the same thoracoabdominal area and

those with more than one compromised region were excluded from the study, as it was impossible to discern which of the wounds had caused the injuries.

A total of 112 patients with single wounds were including with the following distribution: 22 (19%) in the posterior right thoracoabdominal region, 42 (37.5%) in the posterior left thoracoabdominal region, 22 (19%) in the anterior right thoracoabdominal region, and 26 (23.2%) in the anterior left thoracoabdominal region. 95.3% of patients were males, with an average age of 24 years (interquartile range: 20-30). 17% (22/112) of patients were admitted with acute abdomen, and 7% (9/112) were hemodynamically unstable. 33.9% of wounds were located above the eight intercostal space, and 58.2% between the eight and the tenth (Table 1). 60% of wounds were located on the left side, and most of them on the posterior region.

35% of patients had some type of organ injury. The most frequently affected organ was the diaphragm, with 31 cases (27.6%), and 26 of these patients also had injuries to an intraabdominal organ, with the most common being the liver (42.3%), the spleen (26.9%), the colon (26.9%), the stomach (19.2%), the lungs (15.3%), the heart (7.6%), and the gallbladder (7.6%) (Table 2). The thoracoabdominal region with the largest number of associated injuries was the anterior left region, and the least commonly affected was the posterior right region. Surgical procedures performed according to the location of the wounds are described in table 3.

While evaluating the frequency of diaphragmic injuries according to their location, it was found that, out of the 31 injuries, 67.7% were secondary to wounds located in the anterior region, while only 32.2% were associated with posterior wounds. A statistically significant difference was found ($p = 0.002$) according to the injury area for the presence of diaphragmic injury. Posterior injuries showed a relatively lower risk of diaphragmic injury than anterior left wounds. The risk of diaphragm injury in posterior right injuries was a tenth of the risk of injury for anterior left wounds, and the risk of diaphragmic injury in posterior left wounds was lower than half of the risk of diaphragmic injury caused by anterior left wounds (Table 4).

In terms of trauma mechanism and the degree of diaphragmic injury measured according to the organ injury scale system, seven firearm wounds were recorded, five of them were second degree (71.4%) and two were third degree (28.5%); and 24 wounds were caused by bladed weapons, with 14 of them being second degree (58.3%) and 10 third degree (41.6%). No statistically significant differences were

Table 1. Location of wounds in patients with penetrating thoracoabdominal wounds

Intercostal space	Posterior	Anterior	Total cases	Percentage	Cumulative percentage
5	0	5	5	4.46%	4.46%
6	1*	11	12	10.71%	15.18%
7	10	11	21	18.75%	33.93%
8	22	12	34	30.36%	64.29%
9	19	5	24	21.43%	85.71%
10	11	5	16	14.29%	100%
Total	63	49	112	100%	

*Thorax wound due to firearm projectile with thoracoabdominal trajectory.

Table 2. Frequency of organ injuries in patients with penetrating thoracoabdominal trauma

Organ	Percentage
Diaphragm	27.6%
Liver	42.3%
Spleen	26.9%
Colon	26.9%
Stomach	19.2%
Lung	15.3%
Heart	7.6%
Gallbladder	7.6%

found between the location by intercostal space and the presence of wound or degree of diaphragmic injury ($p = 0.66$).

There were 21 complications in 18 patients (16%), with infections being the most frequent, and pneumonia being the most prevalent, with four recorded cases. Coagulated hemothorax was the second most frequent complication, followed by bronchopulmonary fistulas. 9% of patients required some type of re-intervention. No deaths were recorded.

Discussion

Traumas are a public health concern worldwide, as it is the main cause of death within the first three decades of life. In our area, nearly 90% of trauma patients that require some type of surgical procedure are admitted with penetrating traumas¹⁴, and most of

Table 3. Surgical procedures performed in patients with penetrating thoracoabdominal trauma

Diagnosis	Thoracotomy		Thoracostomy		Thoracoscopy		Laparoscopy		Laparotomy	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
ARTAW	23	0	5	18	18	5	20	3	8	15
ALTAW	25	1	9	17	20	6	21	5	8	18
PRTAW	21	1	0	22	20	2	22	0	19	3
PLTAW	38	3	7	34	18	23	41	0	25	16

ARTAW: anterior right thoracoabdominal wound; ALTAW: anterior left thoracoabdominal wound; PLTAW: posterior left thoracoabdominal wound; PRTAW: posterior right thoracoabdominal wound.

Table 4. Risk of diaphragmatic wound according to location in patients with penetrating thoracoabdominal trauma

Thoracoabdominal area	RR	p	CI95%	
Anterior Left	Reference	-	-	-
Anterior right	0.942029	0.85	0.5046865	1.758356
Posterior right*	0.0984848	0.02	0.0138825	0.6986671
Posterior left*	0.4227642	0.02	0.2001855	0.8928198

CI 95%: confidence interval of 95%; RR: risk rate.

*Statistically significant difference.

those who had single wounds with injuries in more than one anatomical region, had them in the thoracoabdominal area¹⁵.

Management of penetrating thoracoabdominal trauma is still a clinical challenge and a subject of debate, from the definition of the limits of the area to the diagnostic and therapeutic approach. The occurrence of associated injuries, complications, and related outcomes has not been described in our population, and taking into account its high prevalence, it must be studied and characterized.

This study found a sociodemographic distribution (age and gender) similar to what has been described by other authors. The ratio of penetrating thoracoabdominal trauma caused by firearm and bladed weapon in developing countries is 3:1¹⁶, which differs from the findings of this study, where the most frequent injury mechanism was bladed weapon (95.3%).

It is worth noting that only 7% of patients were hemodynamically unstable when admitted; however, 17% had acute abdomen, which would be related to the location of most wounds, as 66% had wounds in the eight intercostal space or below, with higher risk of intraabdominal injuries.

60% of wounds were located on the left side, and most of them on the posterior region. The high incidence of injuries in the posterior thoracoabdominal region is essential, as this area has the highest risk of developing a diaphragmic hernia in injuries that are not diagnosed at the time of the trauma, and the highest risk would be due to the supposed protection provided by the liver on the right side, the subrecord of right diaphragmatic injuries (as they are not found actively), and weakness of the left hemidiaphragm in the embryologic fusion planes, such as the pleuroparietal channels¹⁷.

The precordial area (from the lower edge of the clavicles, the anterior left axillary line, right the middle-clavicular line, and the costal edge, including the epigastrium)¹⁸ overlaps the thoracoabdominal area, which implies that a high percentage of these wounds are located on both areas, as reported in this study in 25% of cases; however, despite the high frequency of precordial wounds, only two cardiac injuries were reported in this group of patients.

The percentage of patients with organ injuries was 34% and, even when the majority of patients in this group were admitted for bladed weapon wounds, it must be noted that nearly 70% of patients with firearm wounds had some injury. In line with the findings of Regan et al.¹⁹, out of the intraabdominal injuries, solid viscera were the most commonly affected, in the following order: liver, spleen, and kidneys. It was documented that the most commonly affected area in patients with penetrating thoracoabdominal trauma was the diaphragm (27.6%). It was confirmed that thorax x-rays are a limited diagnostic tool to detect diaphragmatic injuries²⁰, as, in line with global literature, nearly 50% of patients with diaphragmatic injuries has a reportedly normal x-ray⁸.

Despite the fact that the larger number of thoracoabdominal wounds were located in the posterior left region,

the area with the highest risk of diaphragmatic injury was the anterior left region, with a risk 10 times higher compared to the posterior right region and almost twice as high compared to the posterior left region, and no statistically significant difference was found compared to the anterior right region. There were no statistically significant differences found between the location of wounds by intercostal space and the presence of diaphragmatic injury, and these results will have to be evaluated in future studies with larger populations.

Even though the evolution of diaphragmatic wounds is not precisely known, and most of them are low degree, the movement and pressure difference between the abdominal and thoracic cavities could prevent scarring of the defect, favoring the formation of diaphragmatic hernias¹⁷, which justifies searching for them actively. Minimally invasive procedures are preferred in this search, with thorascopies being somewhat superior over laparoscopic procedures in patients with posterior thoracoabdominal wounds, as they allow for easier visualization of this area.

16% of patients had some type of complication, and this percentage is slightly lower than what was reported by Lindarte et al.¹⁴, and most of the complications were in the thorax, with the highest prevalence being coagulated hemothorax. It is worth noting that 75% of cases presented posterior right thoracoabdominal wounds, and the evaluation of the factors associated with this outcome should be made in another study.

Conclusions

The most frequently affected thoracoabdominal area was the posterior left region, but the area with the highest prevalence of diaphragmatic injury was the anterior left region where the risk of diaphragmatic injury is 10 times higher compared to the posterior right region and nearly double compared to the posterior left region. No statistically significant difference was found compared to the anterior right region. Solid viscera injuries are the most common in the abdominal cavity.

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Conflicts of interest

There are no conflicts of interest on the part of the authors.

Ethical disclosures

Protection of people and animals. The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee and with the World Medical Association and the Declaration of Helsinki.

Data confidentiality. The authors declare that they have followed the protocols of their work center regarding the publication of patient data.

Right to privacy and informed consent. The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

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