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SHORT COMMUNICATION

Determining the Prevalence of the Final Causes of Pneumoperitoneum in Trauma Patients

Seyedamir Tabibzadeh Dezfooli[1], Shiva Hosseinian[1]✉, Mehdi Mohammadi[1], Alireza Javan[1], Negin Mousaeinejad[1], Hamidreza Khoshnezhad Ebrahimi[1]

[1] *Emergency Medicine Management Research Center, Health Management Research Institute, Iran University of Medical Sciences, Tehran, Iran*

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Abstract

Introduction: Trauma is one of the leading causes of death and disability in societies, with traffic accidents being the most significant cause of mortality among traumas. Injuries resulting from road traffic accidents are a major public health issue that requires continuous and effective monitoring and coordination, given the emergencies associated with pneumoperitoneum in patients and the prevalence of mortality resulting from it. The present study aimed to investigate the factors that ultimately lead to the presence of air under the diaphragm or pneumoperitoneum in trauma patients.

Methods: This cross-sectional study was conducted at Haft-e-Tir Hospital of Iran University of Medical Sciences (Iran) in 2022 to evaluate trauma patients presenting with pneumoperitoneum. Pneumoperitoneum was diagnosed based on subdiaphragmatic air observed in plain radiography or CT imaging, accompanied by clinical symptoms, such as abdominal pain, vomiting, tachycardia, hypotension, and tachypnea. Data were collected using a pre-prepared checklist, with patient information extracted from medical records and analyzed using the SPSS (version 25) software. Descriptive statistics, chi-square tests, and t-tests were employed for data analysis, with a significance level set at 0.05.

Results: In this study, the records of 287 trauma patients who underwent contrast-enhanced CT scans and met the inclusion criteria were reviewed. Among these, 19 patients were diagnosed with pneumoperitoneum, and two of these patients had concurrent pneumothorax. The mean age of participants was 37.2 years, with men representing a larger proportion of the study population (221 men vs. 66 women). The most common trauma mechanism was accidents, accounting for 244 individuals (84.9% of participants). Among 19 patients with pneumoperitoneum, only eight underwent surgery, with an average pneumoperitoneum volume of 28.97 mL in this group. The remaining patients exhibited point-like pneumoperitoneum and did not require surgical intervention. No significant differences were observed between age (P=0.39), gender (P=0.56), trauma mechanism (P=0.82), and pneumoperitoneum.

Conclusion: Initial observations indicate that the prevalence of pneumoperitoneum in this group of patients is low, and not every patient with pneumoperitoneum necessarily requires surgical intervention.

Key words: Causes, Pneumoperitoneum, Prevalence, Trauma

Introduction

Pneumoperitoneum, defined as the presence of free air within the peritoneal cavity, is a critical clinical sign that often indicates underlying pathology, particularly in trauma patients. The etiology of pneumoperitoneum can be diverse, ranging from traumatic injuries to non-surgical causes, and understanding its prevalence and causes is essential for effective management. In trauma settings, identifying the causes of pneumoperitoneum is crucial, as it can significantly influence treatment decisions and patient outcomes (1).

Trauma-related pneumoperitoneum is

@2025Journal of Surgery and Trauma
Tel: +985632381214
Fax: +985632440488
Po Box 97175-379
Email: jsurgery@bums.ac.ir

✉Correspondence to:
Shiva Hosseinian, Emergency Medicine Management Research Center, Health Management Research Institute, Iran University of Medical Sciences, Tehran, Iran
Telephone Number: +989216432411
Email: shivahoseinian1@gmail.com

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commonly associated with perforations of hollow viscera, such as the gastrointestinal tract, which can occur due to blunt or penetrating injuries. Gastric or duodenal ulcers are frequently cited as leading causes of pneumoperitoneum, particularly in cases where perforation occurs (2). Additionally, the rupture of the diaphragm, although less common, is another potential source of pneumoperitoneum that must be considered in patients with significant thoracic trauma (3). The presence of free air in the peritoneal cavity can also arise from iatrogenic causes, such as post-surgical complications or procedures like paracentesis, which can inadvertently introduce air into the abdominal cavity (4).

The prevalence of pneumoperitoneum in trauma patients can vary significantly based on the mechanism of injury and the population studied. Studies have indicated that in cases of blunt abdominal trauma, the incidence of pneumoperitoneum may be as high as 10% to 15%, particularly when associated with hollow viscus injuries (5).

Non-surgical causes of pneumoperitoneum, while less common, are important to recognize. Conditions like pneumatosis intestinalis, sepsis, and even spontaneous pneumoperitoneum can lead to the accumulation of air in the peritoneal cavity without any overt surgical pathology (5, 6). The identification of these non-surgical causes is critical, as they may require different management strategies compared to surgical causes. For instance, idiopathic spontaneous pneumoperitoneum, although rare, poses a diagnostic challenge and can lead to unnecessary surgical interventions if not properly identified (7, 8).

Recent literature has begun to explore the association between pneumoperitoneum and other conditions, such as pneumothorax and diaphragmatic injuries. Cases have been reported where pneumothorax progressed to pneumoperitoneum due to the dissection of air through the mediastinum and diaphragm (1, 9). The diagnostic approach to pneumoperitoneum typically involves imaging studies, with computed tomography (CT) being the gold standard for identifying the presence of free air and determining its cause (10). However, the sensitivity of plain radiographs in detecting pneumoperitoneum can be limited, particularly in cases of small volumes of air. Therefore, a high index of suspicion and appropriate imaging modalities are essential for accurate diagnosis and management.

Methods

The present cross-sectional study was conducted at Haft-e-Tir Hospital of Iran University of Medical Sciences in Iran. All trauma patients who presented to the emergency department with a diagnosis of pneumoperitoneum during the year 2022 were included. A simple sampling method was employed, including all trauma patients visiting the emergency department of Haft-e-Tir Hospital in 2022 who had been diagnosed with pneumoperitoneum.

The inclusion criteria for trauma patients consisted of individuals over 18 years old who had undergone a contrast-enhanced abdominal CT scan, which included cases of blunt abdominal trauma, multiple trauma, and other blunt traumas for which a contrast-enhanced abdominal CT scan had been performed. Patients were excluded from the study if they were under 18 years old, did not undergo a contrast-enhanced abdominal CT scan, had pneumoperitoneum from non-traumatic causes (e.g., spontaneous or iatrogenic), had incomplete or unavailable medical records, had pre-existing conditions that could independently cause pneumoperitoneum (e.g., perforated peptic ulcer or bowel perforation unrelated to trauma), or declined to participate or for whom consent could not be obtained.

Pneumoperitoneum was diagnosed based on the presence of subdiaphragmatic air observable in plain radiography or, in cases of minimal air, via CT imaging. Patients were evaluated based on radiographic findings at Haft-e-Tir Hospital. Clinical symptoms accompanying pneumoperitoneum included abdominal pain, vomiting, abdominal distension, constipation, fever, diarrhea, tachycardia (heart rate>110 beats per minute), hypotension (systolic blood pressure<100 mmHg), low urine output (<30 ml/hour), and tachypnea (respiratory rate>20 breaths/minute).

The collection of demographic information regarding patients was achieved through a detailed review of medical records at Haft-e-Tir Hospital, focusing on both pneumoperitoneum and its definitive causes.

Following the approval of the ethical code and the research proposal from the research committee, patient lists were obtained from the archives of the hospital. Through a review of medical records, relevant demographic and clinical information related to the trauma and pneumoperitoneum, including age, gender, type of trauma, diagnosed cause of pneumoperitoneum, and any underlying medical conditions, was collected.

After obtaining approval from the ethics

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committee, all collected information was maintained confidentially and anonymously for analysis, adhering to the ethical principles outlined in the Declaration of Helsinki (Ethic Code: IR.IUMS.FMD.REC.1401.691).

Qualitative data were presented as percentages and frequencies, while quantitative data were reported as mean ± standard deviation (SD). Associations between qualitative variables were assessed using chi-square tests. For comparisons involving two means, independent t-tests were employed, a significance threshold of 0.05 was set, and all analyses were conducted using the SPSS (version 25) software.

Results

In the present study, a total of 287 trauma patients who underwent CT scans with contrast were examined. Among these, 19 patients (6.6%) were diagnosed with pneumoperitoneum, indicating a low incidence within this group. Among 19 patients with pneumoperitoneum, two patients presented with simultaneous pneumothorax.

The mean age of all participants was 37.2 years (SD=17.39), with the youngest and oldest participants being 18 and 88 years old, respectively. Specifically, among patients with pneumoperitoneum, the mean age was 36.37 years (SD=13.76).

The statistical analysis using the Independent Samples Test indicated no significant differences between age and pneumoperitoneum (P-value=0.39).

Overall, males constituted a larger proportion of the study population, with 221 males (77%) and 66 females (23%). Among patients with pneumoperitoneum, 15 were male (78.9%) and 4 were female (21.1%). The Chi-Square test indicated no significant differences between gender and pneumoperitoneum (P-value=0.56).

The mechanisms of trauma among participants were as follows: 244 individuals (84.9%) experienced trauma due to accidents, 22 (7.7%) experienced direct trauma (DT), 12 (4.2%) experienced falls, and 9 (3.2%) were classified under other trauma mechanisms. Among patients with pneumoperitoneum, the mechanism distribution was 16 patients (84.2%) due to accidents, 2 (10.5%) due to DT, and 1 (5.3%) due to falls. The demographic and medical characteristics of the 287 trauma patients are presented in Table 1.

Table 1. Demographic and medical characteristics of 287 trauma patients.

Variable		With Pneumoperitoneum	Without Pneumoperitoneum	P-value
Gender, N (%)	Male	15 (78.9)	221 (77)	0.56
	Female	4 (21.1)	66 (23)	
Mechanism of Trauma, N (%)	Accident	16 (84.2)	228 (85.2)	0.82
	Experienced direct	2 (10.5)	20 (7.4)	
	Experienced falls	1 (5.3)	11 (4.1)	
	Other mechanisms	0 (0)	9 (3.3)	
Age, mean±SD		36.37±13.76	37.41±17.63	0.39

The study revealed that among patients diagnosed with pneumoperitoneum, 8 (42.1%) required surgical intervention, while the remaining 11 (57.9%) did not need surgery. The surgical requirement was attributed to the localized nature of the pneumoperitoneum in these patients. Among those who underwent surgery, 1 (12.5%) patient unfortunately passed away.

Among eight patients who were operated on, the source of the pneumoperitoneum was identified in 5 (62.5%) as originating from the intestines and in 3 (37.5%) from the stomach.

The average size of pneumoperitoneum among the surgical patients was 28.97 mm, with a minimum size of 7 mm and a maximum size of 130 mm. In other patients, the pneumoperitoneum was categorized as localized.

Discussion

The results of the present study indicate a low incidence of pneumoperitoneum (6.6%) among trauma patients who underwent CT scans with contrast. This finding aligns with previous literature, which has reported varying incidences of pneumoperitoneum, often influenced by the underlying causes and patient demographics. For instance, Gupta et al. noted that the presence of pneumothorax or pneumomediastinum can indicate spontaneous pneumoperitoneum, which may not always be present in every case (11). This finding suggests that the mechanisms leading to pneumoperitoneum can vary significantly, and the context of the trauma is crucial for understanding the clinical implications.

Regarding demographic information, the mean age of participants in this study was 37.2 years, with a predominance of male patients (77%). This gender distribution is consistent with findings from

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other studies, such as those by Liu et al., which also reported a higher prevalence of pneumoperitoneum in male patients, possibly due to higher exposure to trauma in this demographic (12). Furthermore, the lack of a significant correlation between age and pneumoperitoneum (P-value=0.39) reflects findings from other research that suggest age may not be a critical factor in the development of this condition (8).

The mechanisms of trauma reported in this study predominantly involved accidents (84.9%), which is in line with the literature that identifies traumatic events as a common cause of pneumoperitoneum (13). Notably, the surgical intervention rate among patients with pneumoperitoneum was 42.1%, which is comparable to other studies that have documented surgical intervention rates ranging from 25% to 66% depending on the clinical context and severity of the pneumoperitoneum (14). The identification of the source of pneumoperitoneum in surgical patients, with intestinal perforations being the most common cause, further corroborates findings from various case reports that emphasize the need for surgical intervention in cases of visceral perforation (15).

Moreover, the study's observation that 57.9% of patients with pneumoperitoneum did not require surgical intervention aligns with the concept of non-surgical pneumoperitoneum (NSP), which has been documented in the literature as a condition that can be managed conservatively under specific circumstances (16). The presence of localized pneumoperitoneum without signs of peritonitis supports the notion that not all cases necessitate surgical intervention, as highlighted by Hannan et al., who emphasized the importance of clinical examination in determining the appropriate management strategy (8).

The present work includes several limitations that should be considered when interpreting the results. First, the relatively small sample size, particularly the number of patients diagnosed with pneumoperitoneum, may limit the generalizability of the findings. Additionally, the study was conducted at a single trauma center, which may not fully represent the broader population or account for regional variations in trauma mechanisms and management practices. The retrospective nature of data collection also introduces the potential for information bias, as patient records may lack comprehensive details on clinical presentation and management decisions. Furthermore, variations in imaging techniques and interpretation among different radiologists may influence the accuracy of pneumoperitoneum diagnosis. Finally, given the rapid advancements in trauma care and imaging technology, findings from this study may require periodic reassessment to remain applicable to current clinical practices.

Conclusions

In conclusion, the findings of this research contribute to the existing body of literature on pneumoperitoneum, particularly in trauma patients. The low incidence, demographic characteristics, and management outcomes observed here are consistent with previous studies, underscoring the complexity of pneumoperitoneum as a clinical entity.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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