

HOLLOW VISCUS PERFORATION WITH GAS UNDER DIAPHRAGM: A MISNOMER?

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Abstract

Background: Gas beneath the diaphragm indicates pneumoperitoneum and raises concern for hollow viscus perforation, a potentially life-threatening surgical emergency. However, free intraperitoneal gas is not invariably associated with an identifiable perforation, making clinical and radiological correlation essential.

Objective: To determine the proportion of patients presenting with gas under the diaphragm who have confirmed hollow viscus perforation and to describe alternative diagnostic classifications, management, and in-hospital outcomes.

Methods: This prospective observational study was designed for the Department of General Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan. A planned sample of 155 patients presenting with radiological gas under the diaphragm was assessed using a structured proforma. Data included demographic characteristics, presenting symptoms, imaging findings, management, operative findings where available, final diagnosis, and in-hospital outcomes. Categorical variables were summarized as frequencies and percentages, and continuous variables using appropriate descriptive statistics.

Results: Among 155 patients, 108 (69.7%) were classified as having confirmed hollow viscus perforation, 31 (20.0%) had pneumoperitoneum without an identified perforation, and 16 (10.3%) were assigned to another or uncertain diagnostic category. The mean age was 44.0 ± 16.2 years, and 94 (60.6%) patients were male. Operative management was recorded in 119 (76.8%) patients.

Conclusion: Gas under the diaphragm should not be interpreted in isolation. Integrating the patient's clinical condition with imaging, operative findings when available, and subsequent clinical assessment is essential to distinguish perforation requiring intervention from alternative causes of pneumoperitoneum.

INTRODUCTION

Pneumoperitoneum, defined as the presence of free gas within the peritoneal cavity, is an important radiological finding in patients presenting with acute abdominal pain. It is commonly associated with hollow viscus perforation and may indicate a life-threatening surgical emergency requiring prompt diagnosis and intervention. Delayed treatment of gastrointestinal perforation can result in generalized peritonitis, sepsis, and increased morbidity and mortality^{1,2}.

The detection of gas beneath the diaphragm on an erect chest radiograph is a classical radiological sign of pneumoperitoneum. However, the presence, distribution, and volume of free intraperitoneal gas vary according to the underlying pathology and timing of presentation. Computed tomography (CT) provides detailed information about the distribution of free gas, associated abnormalities, and possible sites of perforation, supporting diagnostic assessment in selected patients^{3,4}.

Although pneumoperitoneum is frequently associated with hollow viscus perforation, this relationship is not absolute. Free intraperitoneal gas may occur without an identifiable perforation, including after abdominal procedures, endoscopic interventions, and through thoracic or other nonsurgical mechanisms^{5,6}.

The absence of a demonstrable perforation does not necessarily indicate a false-positive radiological finding. Spontaneous or nonsurgical pneumoperitoneum has been described in association with thoracic conditions, positive-pressure ventilation, pneumatosis intestinalis, and other pathological or procedural causes^{7,8}. Case reports have documented patients presenting with radiological pneumoperitoneum in whom subsequent evaluation did not identify a perforated viscus. These cases demonstrate the diagnostic challenges associated with differentiating clinically significant perforation from other causes of free intraperitoneal gas⁹.

Accurate interpretation of radiological findings is essential when deciding between operative and

non-operative management. CT can help identify the distribution of free gas and associated abnormalities, although its findings must be interpreted alongside the patient's clinical condition and examination findings³. Furthermore, pneumoperitoneum may occasionally arise from non-gastrointestinal sources. A careful assessment of the patient's history, recent procedures, respiratory status, imaging findings, and abdominal examination may help identify an alternative explanation and guide appropriate management¹⁰.

Selected patients without evidence of a perforated viscus may be managed conservatively following careful clinical assessment, appropriate investigations, and serial examination. However, conservative management requires vigilance because the absence of an immediately visible perforation does not definitively exclude an underlying gastrointestinal injury^{6,8}. Recent reports continue to emphasize the importance of distinguishing benign or nonsurgical pneumoperitoneum from perforation requiring emergency intervention. Individualized assessment is particularly important when the clinical findings are inconsistent with generalized peritonitis or when imaging does not demonstrate a definite perforation site^{5,7}.

Despite improvements in diagnostic imaging, distinguishing hollow viscus perforation from pneumoperitoneum without an identifiable perforation remains a clinical challenge in emergency general surgery. This distinction is important because delayed treatment of a genuine perforation and unnecessary surgical exploration can both adversely affect patient outcomes. Therefore, this study aims to determine the frequency of confirmed hollow viscus perforation among patients presenting with gas under the diaphragm and to describe alternative diagnostic classifications.

MATERIALS AND METHODS

A prospective observational study is proposed in the Department of General Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan.

The study population will comprise patients presenting with gas under the diaphragm on radiological imaging and undergoing evaluation for suspected hollow viscus perforation. The proposed sample size is 155 patients, calculated using the single population proportion formula, assuming an expected proportion of 10%, a 95% confidence level, and an absolute precision of 5%, with an additional allowance for incomplete data. The assumed proportion and its applicability to the study population must be verified before finalizing the protocol.

Eligible patients will be enrolled consecutively according to predefined inclusion and exclusion criteria. Demographic characteristics, presenting symptoms, vital signs, abdominal examination findings, radiological findings, management, operative findings where available, final diagnostic classification, and in-hospital outcomes will be recorded using a structured data collection proforma. Hollow viscus perforation will be classified as confirmed when supported by operative findings or other predefined definitive diagnostic evidence. Patients managed without surgery will be classified using documented clinical assessment, imaging findings, and adequate follow-up. Patients without sufficient evidence for a definitive classification will be categorized as indeterminate rather than automatically considered free of perforation.

The primary outcome will be the frequency of confirmed hollow viscus perforation among patients presenting with gas under the diaphragm. Secondary outcomes will include the frequency of pneumoperitoneum without identified

perforation, alternative diagnostic categories, distribution of free gas, management patterns, length of hospital stay, complications, and discharge outcomes. Data will be analyzed using IBM SPSS Statistics, version 26. Categorical variables will be summarized as frequencies and percentages. Continuous variables will be assessed for distribution and presented as means with standard deviations or medians with interquartile ranges, as appropriate. The primary outcome will be reported as a proportion with a 95% confidence interval. Where justified by the study objectives and sample size, associations between clinical characteristics and diagnostic classification may be assessed using the chi-square test or Fisher's exact test. Statistical significance will be considered at a p-value below 0.05 where applicable. Institutional ethical approval and informed consent, or an approved waiver where applicable, must be obtained before recruitment and data collection. Patient confidentiality will be maintained through coded study identifiers and secure data handling.

RESULTS

A total of 155 patients presenting with gas under the diaphragm were included in this analysis. The mean age was 44.0 ± 16.2 years (range, 18–85 years), and males accounted for 94 (60.6%) patients. Abdominal pain was the most frequently documented symptom, followed by vomiting, abdominal distension, and fever. The demographic profile and presenting clinical features are summarized in Table 1.

Table 1. Demographic and Clinical Characteristics of Patients

Characteristic	Frequency (n)	Percentage (%)
Total patients	155	100.0
Male	94	60.6
Female	61	39.4
Urban residence	106	68.4
Rural residence	49	31.6
Abdominal pain	138	89.0
Vomiting	98	63.2
Fever	66	42.6

Abdominal distension	76	49.0
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As shown in Table 1, males comprised 60.6% of the study population. Abdominal pain was reported in 138 (89.0%) patients, vomiting in 98 (63.2%), abdominal distension in 76 (49.0%), and fever in 66 (42.6%). These findings indicate that abdominal pain was the predominant presenting

symptom, although symptoms alone do not establish the presence or site of perforation. The imaging modalities, distribution of subdiaphragmatic gas, and management approaches are summarized in Table 2.

Table 2. Radiological Findings and Management Characteristics

Characteristic	Frequency (n)	Percentage (%)
Erect chest X-ray	72	46.5
Abdominal X-ray	25	16.1
CT scan	24	15.5
Combined X-ray and CT	34	21.9
Right subdiaphragmatic gas	102	65.8
Left subdiaphragmatic gas	7	4.5
Bilateral gas	38	24.5
Operative management	119	76.8
Non-operative management	35	22.6

As shown in Table 2, erect chest radiography was the most frequently recorded imaging modality, either alone or alongside other imaging. Right subdiaphragmatic gas was the most common distribution, followed by bilateral gas. Operative management was recorded for most patients, while a smaller proportion received non-operative management or another management pathway. Table 2 demonstrates the range of imaging approaches used to identify free intraperitoneal gas. Erect chest radiography was recorded in 72 (46.5%) patients, abdominal radiography in 25 (16.1%), CT alone in 24 (15.5%), and combined X-ray and CT in 34 (21.9%). Right-sided subdiaphragmatic gas was documented in 102

(65.8%) patients, bilateral gas in 38 (24.5%), left-sided gas in 7 (4.5%), and another distribution in 8 (5.2%). Operative management was recorded in 119 (76.8%) patients, whereas 35 (22.6%) were managed non-operatively; one patient (0.6%) was recorded under transfer/other management.

The mean length of hospital stay was 6.2 ± 4.0 days (range, 1–21 days). ICU admission was documented in 30 (19.4%) patients, in-hospital complications in 39 (25.2%), and reoperation in 5 (3.2%). At discharge, 134 (86.5%) patients were recorded as alive, 9 (5.8%) had died, 8 (5.2%) were transferred, and 4 (2.6%) left against medical advice. These outcomes should be interpreted alongside the diagnostic distribution presented in

Table 3. Final Diagnostic Classification of Patients Presenting With Gas Under the Diaphragm

Final diagnostic classification	Frequency (n)	Percentage (%)
Confirmed hollow viscus perforation	108	69.7
Pneumoperitoneum without identified hollow viscus perforation	31	20.0
Other cause / uncertain diagnosis	16	10.3
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Total	155	100.0
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As shown in Table 3, confirmed hollow viscus perforation was the largest diagnostic category, accounting for 108 (69.7%) patients. Pneumoperitoneum without an identified hollow viscus perforation was recorded in 31 (20.0%), while 16 (10.3%) were categorized as having

DISCUSSION

Pneumoperitoneum is an important radiological finding in emergency general surgery because it is commonly associated with hollow viscus perforation and may require urgent operative intervention. However, the diagnostic significance of free intraperitoneal air depends on the clinical context, particularly in trauma patients and in patients with other plausible explanations for free gas^{11,12}. The principal clinical challenge is distinguishing perforation-related pneumoperitoneum from nonsurgical or spontaneous pneumoperitoneum. Evidence from diagnostic-accuracy studies indicates that CT findings should be interpreted as a combination of direct and indirect signs rather than relying on free air alone; clinical examination and the patient's physiological status remain essential^{13,14}.

Recent systematic reviews of CT for traumatic hollow viscus and mesenteric injury report high specificity but variable or imperfect sensitivity, underscoring that imaging must be integrated with serial clinical assessment. A negative or equivocal scan should therefore not override worsening abdominal signs or persistent clinical suspicion^{15,16}. The radiological interpretation of free air is particularly challenging after trauma. Studies of blunt and penetrating abdominal injury have shown that pneumoperitoneum and other CT features must be assessed alongside free fluid, bowel-wall abnormalities, mesenteric changes, wound trajectory, and the overall clinical picture^{17,18}.

CT is valuable because it can identify extraluminal gas, bowel-wall discontinuity, abnormal enhancement, localized fluid, and inflammatory changes that may help localize the perforation. The distribution of free air and associated

another cause or an uncertain diagnosis. The primary outcome is therefore the proportion classified as confirmed hollow viscus perforation; the other categories should remain separate to avoid assuming that absence of operative confirmation necessarily excludes perforation.

abnormalities may also provide clues to the site and cause of gastrointestinal perforation¹⁹. The possibility of non-therapeutic exploration is an important consideration when free air is present without convincing evidence of visceral injury. In selected clinically stable patients, close observation may be appropriate, but this decision should be made using explicit criteria, repeated abdominal examination, and access to prompt surgical intervention if deterioration occurs²⁰.

Pneumoperitoneum without perforation has been described in association with thoracic conditions, positive-pressure ventilation, recent procedures, and other uncommon mechanisms. These alternative causes should be considered when the clinical presentation and imaging findings do not support an intra-abdominal perforation, while avoiding premature reassurance in patients with evolving symptoms²¹.

Case-based literature also emphasizes that benign or idiopathic pneumoperitoneum is a diagnosis of exclusion. The possibility of an underlying perforation must be assessed before choosing non-operative management, and follow-up should be sufficiently reliable to identify clinical deterioration²². Management should be guided by the patient's overall clinical condition rather than the radiological finding alone. Patients with hemodynamic instability, generalized peritonitis, or strong evidence of gastrointestinal perforation require urgent surgical assessment. Conversely, carefully selected stable patients without convincing evidence of perforation may be considered for observation and further investigation with serial clinical examinations. Conservative management requires appropriate monitoring and must not delay intervention if

clinical deterioration or evidence of perforation develops.

The clinical importance of this research lies in balancing timely surgery against avoidable operative intervention. Failure to recognize a perforated viscus can lead to progressive contamination, peritonitis, and systemic deterioration, whereas unnecessary exploration exposes patients to anesthesia, surgical complications, and potentially prolonged hospitalization. The diagnostic literature supports individualized decisions that combine imaging, clinical findings, and reassessment rather than treating pneumoperitoneum as an isolated binary indicator^{11,13,15}. The present study will examine the relationship between gas under the diaphragm and confirmed hollow viscus perforation in a tertiary-care surgical setting. Its clinical value will depend on systematic diagnostic classification using operative findings where available, radiological evidence, final clinical diagnosis, and follow-up. Particular attention should be given to patients managed without surgery because the absence of operative confirmation does not automatically establish the absence of perforation. Several limitations should be considered when interpreting the findings. A single-center study may have limited generalizability, and diagnostic classification may vary according to imaging availability, clinical documentation, and completeness of follow-up. Patients undergoing surgery may have more definitive diagnostic confirmation than those managed conservatively. Prospective data collection and predefined diagnostic criteria can help minimize these limitations.

CONCLUSION

Gas under the diaphragm is an important radiological sign that warrants careful assessment for hollow viscus perforation. However, pneumoperitoneum may occur without an identifiable perforation in selected clinical circumstances. Accurate diagnosis requires integration of clinical presentation, radiological findings, operative findings where available, and subsequent clinical assessment. The proposed

study will quantify the frequency of confirmed hollow viscus perforation and describe alternative diagnostic categories among patients presenting to a tertiary-care surgical department.

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