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# MANAGEMENT OF DIFFERENT TYPES OF PNEUMOTHORAX IN CATS: A RETROSPECTIVE STUDY OF 41 CASES (2022-2024)

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***Abstract***

*Pneumothorax in cats is most commonly associated with thoracic trauma. However, increasing use of computed tomography (CT) has revealed a subset of affected cats with pulmonary bullae or blebs, traditionally linked to spontaneous pneumothorax. This raises important questions about the classification of pneumothorax in feline trauma cases. This retrospective study analysed 41 cats diagnosed with traumatic pneumothorax at the University Veterinary Emergency Hospital "Prof. Dr. Alin Bîrțoiu" between 2022 and 2024. Diagnostic workup included PoCUS, thoracentesis, CT, and necropsy. Data on trauma type, thoracentesis volume, imaging findings, surgical interventions, and outcomes were collected. Persistent or recurrent pneumothorax was documented in 17 cats, with CT or necropsy confirming bullous or bleb-related pathology in 11 cases. Six cats underwent emergency thoracic surgery (5 lobectomies via thoracotomy, 1 via sternotomy), with a postoperative survival rate of 83.3%. Pulmonary contusions were present in 85.3% of cats. Thoracentesis air extraction ranged from 15 mL to 600 mL per session (mean: 137 mL). Four additional cats required chest tube placement. All conservative cases received oxygen and opioid-based analgesia; NSAIDs were used selectively after cardiovascular stabilization. Four non-surgical deaths were linked to undiagnosed bullae or contusions. Findings support a reconceptualization of pneumothorax classification in cats. Trauma may not only rupture pre-existing bullae but also induce their formation. Early CT imaging and surgical intervention can significantly improve survival in refractory cases. The overlap between traumatic and spontaneous pneumothorax warrants a more nuanced diagnostic framework in feline thoracic trauma.*

***Key words:*** *Spontaneous pneumothorax, bullae, blebs, lobectomy, trauma.*

## INTRODUCTION

Pneumothorax, the accumulation of free air within the pleural space, causes lung collapse and respiratory distress in cats (King, 2015). It is traditionally classified by ethiology as traumatic, spontaneous, or iatrogenic (Silverstein & Hopper, 2014). Traumatic pneumothorax is the most common form in cats, typically resulting from blunt force trauma (e.g., road traffic accidents or falls) or penetrating injuries to the chest (Tobias & Johnston, 2017). A traumatic pneumothorax may be open (with a chest wall defect) or closed, and affected cats often present in acute respiratory compromise requiring emergency stabilization (Schrader & Monnet, 2011).

Spontaneous pneumothorax occurs without a history of external trauma and can be further categorized as primary (idiopathic) or secondary (due to underlying lung pathology) (Sayegh et al., 2020). In cats, secondary spontaneous pneumothorax is more frequently observed and is associated with underlying diseases such as pneumonia, feline asthma, parasitic infection, neoplasia, or pulmonary bullae and blebs (Culp & Drobatz, 2007; Goring et al., 2009). Pulmonary bullae are air-filled cystic lesions in the lung parenchyma that can rupture and lead to spontaneous pneumothorax (Fossum, 2019). These bullous lesions are a well-recognized cause of spontaneous pneumothorax in dogs, whereas cats with spontaneous pneumothorax often have identifiable inflammatory or neoplastic lung disease in addition to or instead of bullae (Hayashi et al., 2016). Nonetheless, bullae do occur in cats and can cause recurrent or non-resolving pneumothorax (Williams et al., 2018). Iatrogenic pneumothorax, while least common, may result from diagnostic or therapeutic interventions such as thoracentesis, positive-pressure ventilation, or chest trauma during surgery (Wininger et al., 2013).

Severe blunt trauma can on occasion lead to delayed pneumothorax due to pulmonary bullae formation. Trauma-induced bullous rupture has

been reported anecdotally in veterinary medicine (Tschopp et al., 2006). In such cases, a cat may suffer an initial chest injury that later gives rise to a pulmonary bleb or bulla which ruptures days to weeks after the trauma, effectively causing a secondary spontaneous pneumothorax attributable to the prior injury (Leigh-Smith & Harris, 2005). Distinguishing these cases from true primary spontaneous pneumothorax is important, as their management may require surgical intervention similar to spontaneous cases, despite the traumatic origin. Advanced imaging such as CT can be invaluable in identifying occult bullae in both spontaneous and trauma-related pneumothorax cases (Uzun et al., 2023).

Management of pneumothorax in cats depends on the type and severity of the condition. Minor traumatic pneumothorax cases often resolve with conservative management, including oxygen supplementation and one or two thoracentesis procedures to remove intrapleural air. In more severe or persistent cases, especially those with large air leaks, indwelling thoracostomy tube placement is indicated to continuously evacuate air until the lung seals. Spontaneous pneumothorax cases, particularly when caused by ruptured bullae, frequently require surgical management to prevent recurrence. Partial or complete lung lobectomy of affected lobes, typically using a stapling device, is the treatment of choice for bullae in both dogs and cats. Previous studies suggest that prompt surgical intervention in spontaneous pneumothorax can improve outcomes, although some cats have been managed successfully with prolonged chest tube drainage alone. There is relatively limited literature directly comparing the clinical course and outcomes of traumatic versus spontaneous pneumothorax in cats.

Spontaneous pneumothorax in cats has historically been considered rare or underreported, likely due to limited access to advanced imaging techniques such as computed tomography (CT). Earlier studies reported very few cases in feline patients, with most pneumothorax diagnoses attributed to trauma or iatrogenic causes (Silverstein & Hopper, 2014; King, 2015). However, more recent publications indicate that pulmonary bullae and blebs may be underdiagnosed without cross-sectional imaging (Schrader & Monnet, 2011; Tobias & Johnston, 2017). This evolving diagnostic perspective highlights the need to revisit current classification frameworks for pneumothorax in feline patients, especially in trauma associated cases.

The aim of this retrospective study was to review the presentation, diagnostic findings, management, and outcomes of cats with pneumothorax of different ethiologies. We hypothesized that most cats with traumatic pneumothorax would have a benign clinical course and high survival with minimally invasive management.

However, in a subset of trauma patients, pneumothorax associated with pulmonary bullae or blebs - likely trauma-induced or trauma-triggered - would result in persistent air leakage and require surgical intervention. Moreover, our clinical findings in cats with severe pneumothorax suggest that thoracic trauma itself may contribute to the formation of pulmonary bullae or blebs.

## MATERIALS AND METHODS

This study was a retrospective review of medical records from cats diagnosed with pneumothorax at a veterinary referral hospital between January 2018 and December 2024. Cases were identified through the hospital's database by searching for the diagnosis of pneumothorax or related terms. For each cat, data collected included age, breed, sex (and neuter status), body weight, pneumothorax ethiology (traumatic, spontaneous, or iatrogenic), diagnostic methods, treatment interventions, and outcome.

Inclusion criteria for the study were:

• Cats of any age, sex, or breed with a confirmed pneumothorax diagnosis (via thoracic radiography, ultrasound, or CT) during the study period.

• Sufficient medical record details regarding diagnostics, treatment, and outcome.

Exclusion criteria included cases where pneumothorax was suspected but not definitively confirmed, or cases with significant concurrent thoracic conditions (e.g., large pleural effusion or diaphragmatic hernia) that could confound assessment of the pneumothorax management.

Pneumothorax ethiology was classified as traumatic if there was a known recent history of trauma (such as vehicular trauma or fall),

spontaneous if no trauma was reported (further classified as secondary if an underlying lung lesion was identified), or iatrogenic if it occurred secondary to a veterinary procedure. The diagnostic approach in each case typically involved thoracic radiographs as the initial modality to confirm pneumothorax and assess for rib fractures or other injuries. Point-of-care ultrasound (PoCUS) of the thorax was also employed in some acute cases to rapidly identify the absence of lung sliding (confirming free pleural air).

Advanced imaging with thoracic CT was performed in cases where underlying pulmonary pathology was suspected, particularly for all spontaneous pneumothorax cases and any traumatic cases with persistent air leakage or unclear findings. CT scans were reviewed for the presence of bullae, blebs, lung lobe torsion, or other lesions that might necessitate surgical intervention.

Decisions regarding management were made by the attending clinicians based on standard emergency and surgical practice. In general, if one or two needle thoracentesis successfully resolved the pneumothorax and the cat remained stable, no further invasive treatment was pursued. However, if there was recurring or tension pneumothorax, or if the lung failed to remain expanded, an indwelling thoracostomy tube (chest tube) was placed for continuous evacuation of air. The chest tubes used (Mila™ thoracic catheters) were connected to a closed suction drainage system and monitored for air production.

Surgical intervention (thoracotomy or sternotomy) was recommended in cases with identified bullous lesions on imaging or if there was a continuous air leak for more than 48h to 72 hours despite chest tube suction. When surgery was performed, to the affected lung lobe(s) as total or partial lobectomy using a thoracic stapler device to ensure a secure closure of airway and vessels. All surgical cases had a chest tube placed at surgery for postoperative care.

Anaesthesia and perioperative care followed standard protocols for thoracic surgery in cats, including multimodal analgesia and thoracic epidural if indicated. Postoperative management involved continued chest tube suction until air leakage ceased, oxygen support as needed, and serial thoracic radiographs to monitor lung re-expansion.

For each case, outcome was defined as survival to hospital discharge or death/euthanasia. The duration of hospitalization and any complications (such as persistent air leak, re-expansion pulmonary oedema, or surgical complications) were recorded. No experimental procedures were performed as part of this study; all treatments were clinically indicated. Owner consent for use of de-identified case data was obtained where required, and institutional ethical approval for the study protocol was granted by the hospital's clinical research committee.

Data analysis was descriptive. Continuous data (such as age and volumes of air removed) are presented as median and range, given the small sample size. Categorical data (such as pneumothorax type and survival outcome) are reported as counts and percentages. No statistical hypothesis testing was performed due to the limited sample size; the study's focus was to summarize and compare management approaches and outcomes across pneumothorax types.

## RESULTS

A total of 41 cats met the inclusion criteria for traumatic pneumothorax between January 2022 and December 2024. All cases presented to the University Veterinary Emergency Hospital "Prof. Dr. Alin Bîrțoiu". Diagnoses were made using point-of-care ultrasound (PoCUS) and thoracentesis in all patients. Computed tomography (CT) was used selectively, particularly in cats with persistent or recurrent pneumothorax. Thoracic radiographs were performed only in clinically stabilized patients to avoid exacerbating respiratory distress or compromising safety.

The majority of cases (n = 32) resulted from high-rise syndrome (HRS), followed by vehicular trauma (HBC) in 6 cats and trauma of unknown origin in 3 cats. One HBC case also involved craniomaxillofacial (CMF) injury.

All 41 cats received oxygen therapy and pain management, typically including opioids, as part of initial stabilization. CT imaging was performed in 11 cats, generally when pneumothorax was refractory to thoracentesis.

## Trauma Ethiology and Outcomes

Of the 41 cats included in the study, high-rise syndrome (HRS) was the most common cause of traumatic pneumothorax, accounting for 32 cases (78%). Vehicular trauma (HBC) accounted for 6 cases (15%), including one cat with associated craniomaxillofacial (CMF) injuries. The remaining 3 cases (7%) involved trauma of unknown origin.

Most HRS cases (n = 27) recovered with conventional treatment. Three HRS cats underwent lung lobectomy surgery: two survived and one died postoperatively (suspected barotrauma). Two additional HRS cats died prior to surgical intervention. In the HBC group (n = 6), three cats underwent surgery and survived; the remaining three died before surgery. All cats with unknown trauma (n = 3) recovered with conventional treatment. These findings are detailed in Table 1.

Table 1. Case Distribution by Trauma Type and Outcome

| Trauma Type | Total Cats | Surgical Cases | Survived (Conservative/Surgical) | Died (Pre-op/Post-op) |
|---|---|---|---|---|
| High-Rise Syndrome (HRS) | 32 | 3 | 27 / 2 | 2/1 |
| Hit by Car (HBC, incl. CMF) | 6 | 3 | 0/1 | 3/0 |
| Unknown Trauma | 3 | 0 | 3/0 | 0/0 |

## Thoracentesis and Chest Tube Placement

All 41 cats underwent thoracentesis as part of emergency stabilization. In 12 cats, a single thoracentesis session was sufficient for clinical resolution. The remaining 29 cats required multiple thoracentesis procedures due to persistent or recurrent pneumothorax.

In cases where air volume was recorded, thoracentesis yielded between 15 mL and 300 mL of air per session. The mean extracted volume was 137 mL, and the median was 67.5 mL, reflecting variability in pneumothorax severity and recurrence. Indicating a wide variability in pneumothorax severity and recurrence (Table 2).

Table 2. Thoracentesis frequency and chest tube placement summary in 41 cats with traumatic pneumothorax

| Category | Value |
|---|---|
| Total cats | 41 |
| Thoracentesis - Single session | 12 cats (resolved) |
| Thoracentesis - Multiple sessions | 29 cats |
| Air volume per session | 15mL-300mL (Mean: 137mL, Median: 67,5mL) |
| Chest tube placement - In surgery | 6 |
| Chest tube placement - Without surgery | 4 |
| Total cats with chest tubes | 10 |

Chest tube placement was performed in a total of 10 cats: 6 cats received chest tubes intraoperatively as part of surgical management 4 cats had chest tubes placed during non-surgical management due to recurring or severe pneumothorax. Detailed counts and breakdowns are summarized in Table 3.

In select cases, chest tubes were connected to a Heimlich valve system to facilitate one-way air evacuation. An example is illustrated in Figure 1, showing in situ placement with external tubing for continuous drainage.

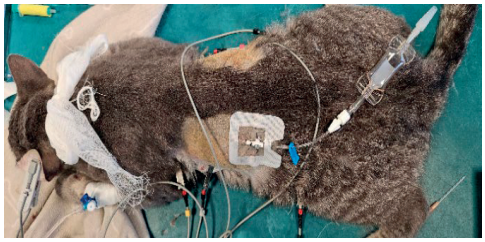

Figure 1. A sedated and intubated cat undergoing thoracic drainage with a MILA Guidewire Chest Drain and Heimlich valve. This setup was used in select non-surgical cases with persistent or recurrent pneumothorax following multiple thoracentesis procedures (original Dr. Uzun, FMVB).

## Medical Management and Conventional Treatment

Pneumothorax that managed without surgery (n=35) received supplemental oxygen and analgesia as part of their stabilization and recovery protocol. Pain management typically included opioids, such as buprenorphine, administered intravenously.

Non-steroidal anti-inflammatory drugs (NSAIDs) were used selectively and only after cardiovascular stabilization.

Their administration was based on clinician discretion and the absence of hemodynamic compromise, as NSAIDs, although synergistic with opioids, may mask subtle clinical deterioration in trauma patients.

Antibiotics were administered on a case-by-case basis, typically in patients with suspected pulmonary laceration, infection, or prolonged thoracostomy tube placement.

Supportive care also included monitoring for recurrence of dyspnoea, repeat thoracentesis when necessary, and imaging to confirm resolution. Most cases treated conventionally recovered without complication. Table 3,

summarizes analgesic, anti-inflammatory, and adjunctive therapies across non-surgical cases.

Table 3. Medical Management in Non-Surgical Cats, summarizing the core therapeutic strategies applied across the 35 conservatively managed cases.

| Treatment Modality | Applied In |
|---|---|
| **Oxygen therapy** | All 35 non-surgical cats |
| **Opioid analgesia (e.g., buprenorphine)** | All 35 non-surgical cats |
| **NSAIDs (selective use)** | Subset after cardiovascular stabilization |
| **Antibiotics (based on clinical suspicion)** | Subset with suspected infection or laceration |
| **Repeat thoracentesis (if needed)** | 29 cats with recurrent pneumothorax |
| **Monitoring and imaging follow-up** | All conventional cases |

## CT Imaging and Bullae Detection

Computed tomography (CT) was performed in seven cats exhibiting persistent or recurrent pneumothorax that failed to resolve following initial stabilization with thoracentesis and oxygen therapy. In all seven cases, CT imaging confirmed the presence of pulmonary bullae or blebs, supporting a diagnosis of structurally compromised lung parenchyma as the underlying cause of pneumothorax persistence. These lesions were located across various lobes, with some cats exhibiting focal, singular defects and others showing more diffuse, multi-lobar pathology.

CT findings were pivotal in determining the appropriate management strategy. In six of the seven CT-confirmed cases, the imaging results directly influenced the decision to pursue surgical intervention, typically via targeted pulmonary lobectomy. The remaining cat was successfully managed conservatively and recovered without requiring surgery, highlighting that CT findings may also support non-surgical decision-making in select cases.

Lesion characterization on CT revealed three cats with single, large bullae measuring between 1.5 and 2.5 cm in diameter, most frequently located in the cranial and middle lung lobes. In contrast, several cats demonstrated multiple small blebs scattered across multiple lobes, consistent with diffuse pulmonary fragility. Notably, one cat exhibited bullous changes adjacent to pulmonary contusions and a healing rib fracture, suggesting a trauma-associated origin for the lesion rather than a pre-existing congenital abnormality.

Importantly, no CT scans demonstrated evidence of pulmonary neoplasia, abscessation, or thromboembolic disease as alternate causes for the observed bullae or blebs. This absence of secondary pathology supports the conclusion that trauma, either through direct parenchymal disruption or pressure-related injury, likely played a central role in the development or rupture of these pulmonary lesions.

These findings are summarized in Table 4, with representative CT images provided in figures 1–6. Together, the CT data underscore the utility of advanced imaging in both diagnostic clarification and therapeutic planning in cats with complex pneumothorax presentations.

The presence, location, and number of bullae informed surgical decisions and guided the approach. CT imaging allowed for precise identification of affected lobes, facilitating targeted lobectomy where indicated. These findings are summarized in Table 4, and representative CT images from select cases are provided in figures 2, 3 and 4.

## Pulmonary Contusions and Hemothorax

Pulmonary contusions were diagnosed in 35 of 41 cats (87.5%) based on clinical assessment and imaging findings. These injuries were frequently observed in conjunction with pneumothorax, example text and proper formatting.

Table 4. CT-confirmed pulmonary bullae or blebs in seven cats with traumatic pneumothorax

| Case No. | Trauma type | CT Confirmed bullae/blebs | Lobe(s) affected | Lung lobectomy | Outcome |
|---|---|---|---|---|---|
| **Case 1** | HBC | Yes | Left cranio-caudal (LCr-Ca) | Yes | Survived |
| **Case 2** | HRS | Yes | Right Cranial (RCr) & Right middle (RM) | Yes | Survived |
| **Case 3** | HRS | Yes | Left caudal (RCa) | Yes | Survived |
| **Case 4** | Unknown trauma | Yes | Left caudal (LCa) | No | Survived |
| **Case 5** | HRS | Yes | All left lung lobes | Yes (Sternotomy) | Died |
| **Case 6** | HRS | Yes | Right middle (RM) | No | Died |
| **Case 7** | HBC | Yes | Right middle (RM) | Yes | Survived |

Figure 2. Computed tomography (CT) scan of the thorax in Case 1, a cat with persistent pneumothorax following vehicular trauma. CT imaging reveals a well-defined, gas-filled bullous lesion (yellow arrow) located in the right middle lung lobe, consistent with a traumatic pulmonary bulla. A focal area of increased pulmonary opacity (blue arrow) is also visible in the contralateral lung, suggestive of pulmonary contusion. The imaging findings contributed to surgical decision-making and confirmed the coexistence of bullous and contusional pathology (original radiology department FMVB).

Figure 3. Computed tomography (CT) scan of the thorax in Case 2, a cat with recurrent pneumothorax following high-rise syndrome. CT imaging reveals multiple gas-filled bullae (short yellow arrows) within the right cranial and middle lung lobes. A large lobar air-trapping pattern and parenchymal distortion are also visible. Presence of pneumothorax (yellow star), consistent with air leakage secondary to bullous rupture. This rupture also confirmed in lung lobectomy surgery (original radiology department FMVB).

Figure 4. Transverse CT scan of the thorax in Case 4, a cat presenting with non-resolving pneumothorax following unknown trauma. Large bullae (black arrows) are clearly visible within the left caudal lung lobe, surrounded by distorted parenchyma. Despite the presence of significant bullous, the cat was managed conservatively without surgical intervention and made a full recovery (original radiology department FMVB).

**Surgical Intervention**

Emergency thoracic surgery was performed in six cats with persistent or recurrent pneumothorax and CT-confirmed or strongly suspected pulmonary bullae or blebs.

Five cats underwent intercostal thoracotomy, and one cat underwent a median sternotomy due to complex bilateral pathology. All lung lobectomies were performed using a WATSON® YiTian II Disposable Endoscopic Stapler, ensuring rapid vascular and bronchial isolation. Affected lobes were resected at the hilus when possible, or more peripherally if adhesions or contusions limited exposure. Care was taken to avoid tension or tearing of adjacent lobes. Following lobectomy, all surgical cases received a MILA® Guidewire Chest Drain (14ga × 20 cm) placed intraoperatively prior to closure. Postoperative management included oxygen supplementation, multimodal analgesia, and close monitoring of chest tube output.

Thoracic radiographs were obtained in all cats following surgical lung lobectomy to evaluate lung re-expansion, verify chest tube placement, and confirm the integrity of the stapling line. Lateral and ventrodorsal projections were typically acquired once the patient was hemodynamically stable and adequately oxygenated.


Figure 5a-5b. Intraoperative appearance and excised lung lobe in Case 1. (a) Thoracotomy exposure reveals a focal subpleural bullous lesion in the LCr-Ca lung lobe. The lesion appears raised and thin-walled, consistent with a ruptured bulla or bleb, and is situated near an area of consolidated parenchyma. (b) Gross appearance of the excised lung lobe. The resected specimen demonstrates multifocal dark discoloration and a prominent bulla measuring approximately 1.5 cm, correlating with preoperative CT findings (original Dr. Uzun, FMVB))

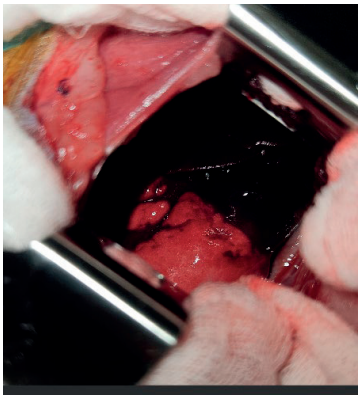

Figure 6. Intraoperative thoracotomy findings in Case 2. Thoracic cavity exposure reveals a visibly of RCr lobe, total atelectasis, haemorrhage with bullous pathology and parenchymal compromise. Partially atelectatic RM lobe with bullae formation (original Dr. Uzun, FMVB)

One of the cats presented during the night shift with acute respiratory distress following hit-by car trauma. Despite multiple air evacuations, pneumothorax rapidly recurred.

After intubation MILA® Guidewire Chest Drain (14ga × 20 cm) was placed and connected to a Heimlich valve.

Due to the unavailability of CT imaging overnight and the cat's deteriorating status, emergency thoracotomy was elected. Intraoperatively, the left cranio-caudal (LCr-Ca) lung lobe appeared atelectatic. Examination of the excised lung lobe revealed a focal ruptured bullous lesion, consistent trauma-induced bullae formation (Figure 7a, 7b).

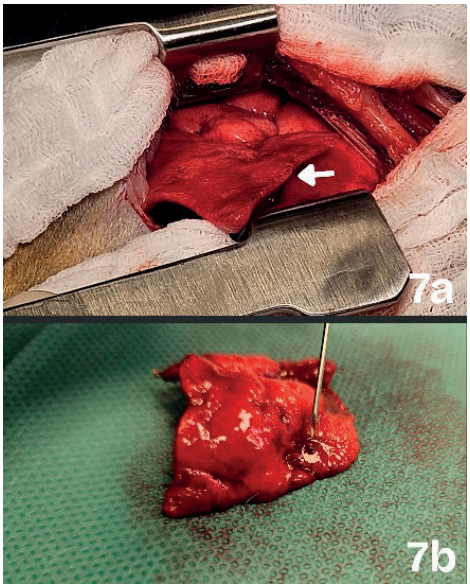


Figure 7. Intraoperative findings during emergency thoracotomy in Case 8. (a) Thoracic cavity exposure reveals a focally atelectatic. White arrow points multiple blebs. (b) Excised LCr-Ca lobe following lobectomy, displaying a focal ruptured bullous lesion and small bleb existence (marked by a needle). The lesion appears sharply demarcated, consistent with trauma-induced pulmonary bullae or bleb rupture, without evidence of diffuse pulmonary pathology (original Dr. Uzun, FMVB)

**Postmortem – Necropsy findings**

Postmortem examinations were performed in four non-surgical cats that died due to traumatic pneumothorax. Necropsy revealed pulmonary bullae or blebs corresponding to bullous emphysema.

The bullous lesions were typically focal and well-demarcated, often affecting the cranial or middle lung lobes, and appeared consistent with trauma-induced pathology.

In addition to bullae, all four cases exhibited varying degrees of pulmonary contusions, alveolar haemorrhage, and parenchymal collapse, supporting a multifactorial mechanism of respiratory compromise.

No evidence of neoplasia, abscess formation, or thromboembolic disease was observed in any of the necropsied cases. These findings reinforce the clinical relevance of early diagnostic imaging, as undetected bullae or extensive pulmonary damage may contribute significantly to fatal outcomes in feline thoracic trauma when surgery is not pursued.

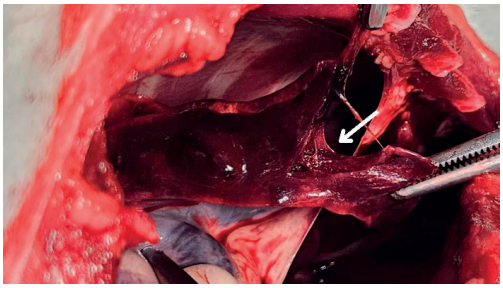

Figure 10. Postmortem thoracic image from a non-surgical fatal pneumothorax case. A large ruptured subpleural bulla (white arrow) is visible on the dorsal surface of the right caudal lung lobe. The surrounding parenchyma appears dark red, dense consistent with contusions and subsequent congestion and haemorrhage (original Dr. Uzun, FMVB)

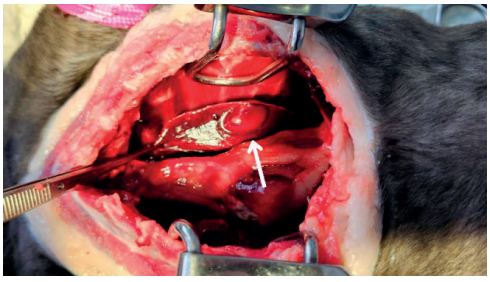

Figure 11. Postmortem thoracic cavity in a non-surgical case of fatal pneumothorax. A large, well-defined bullous lesion (white arrow) is visible on the dorsal aspect of a lung lobe, consistent with trauma-induced bullae. The adjacent tissue shows no overt signs of infection or neoplasia (original Dr. Uzun, FMVB)

## DISCUSSIONS

This retrospective analysis of 41 feline cases of traumatic pneumothorax provides compelling clinical evidence for re-evaluating the conventional dichotomy between spontaneous and traumatic pneumothorax in cats. While trauma remains the dominant ethiology in veterinary emergency presentations, the detection of pulmonary bullae and blebs in a significant subset of these patients – often confirmed through computed tomography (CT) or post-mortem examination – raises questions about the underlying mechanisms driving persistent or recurrent pneumothorax in trauma patients.

Historically, spontaneous pneumothorax in cats was considered rare, largely due to the limited availability of advanced imaging modalities such as CT. Earlier studies in both human and veterinary literature reported low incidence rates, attributing most feline cases of pneumothorax to either traumatic or iatrogenic causes. However, as shown in our study and supported by more recent work, pulmonary bullae and blebs may be significantly underdiagnosed without cross-sectional imaging, particularly in patients with persistent pneumothorax despite appropriate stabilization.

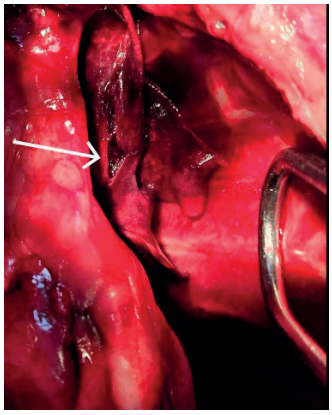

Figure 12. Postmortem thoracic examination revealing severe pulmonary contusion. A necropsy image from a non-surgical fatal case of traumatic pneumothorax. The arrow indicates a markedly discoloured and collapsed pulmonary lobe consistent with extensive contusion. The affected tissue displays, friable regions suggestive of parenchymal compromise and alveolar rupture. Findings correlate with pre-mortem respiratory distress and rapid decompensation (original Dr. Uzun, FMVB)

More importantly, our findings suggest that in some cases, trauma may not merely rupture pre-existing bullae but may actually contribute to their formation. In seven CT-confirmed surgical cases, bullous lesions were identified in cats with no prior respiratory history. This supports a growing body of clinical thought suggesting trauma-induced alveolar rupture, parenchymal shearing, or pressure fluctuations may lead to the development of bullae or blebs. Similar pathophysiologic considerations have been

proposed in human trauma cases, particularly those involving blunt chest trauma without prior lung disease.

In such scenarios, classification under "traumatic spontaneous pneumothorax" or "trauma-associated bullous rupture" may be more appropriate and clinically descriptive.

Among our surgical cohort, five out of seven cats recovered successfully following lobectomy, all performed using endoscopic staplers. Just one case unfortunately succumbed postoperatively, following a sternotomy.

Importantly, our non-surgical cohort included four cats who died prior to surgical intervention and were later found on necropsy to have significant pulmonary pathology, including ruptured bullae and contusions—again underscoring the overlap between trauma and pathological air leakage. These cases further support the argument that persistent pneumothorax in trauma should raise suspicion for structural lung lesions, even in the absence of CT.

Additionally, pulmonary contusions were identified in 35 of 41 cats (85.3%), often coexisting with pneumothorax. While many of these cats were managed conservatively, severe or progressive cases required surgical intervention. One notable survivor underwent successful lobectomy following massive haemothorax and transfusion, further highlighting that surgical management can be effective even in patients with complex trauma.

The clinical decision to operate in feline trauma cases with pneumothorax remains nuanced. CT should be considered when air leakage persists despite thoracentesis, and especially when air volume exceeds 200 mL repeatedly – as was seen in several of our patients. The use of thoracostomy tubes and Heimlich valves provided temporary stabilization in select cases, although they were not curative in those with underlying bullous disease.

Our findings advocate for a more integrative diagnostic framework that considers trauma-induced pulmonary pathology – including bullous lesions – as part of the differential in any feline patient with refractory pneumothorax. This is especially critical given the relatively high survival rate (83%) among cats that underwent timely surgical intervention in this study.

## CONCLUSIONS

This study represents one of the most comprehensive retrospective analyses of traumatic pneumothorax in feline patients to date, highlighting not only the clinical diversity of thoracic trauma but also the diagnostic and therapeutic challenges associated with persistent or recurrent pneumothorax. Our findings support a paradigm shift in the classification and management of pneumothorax in cats by revealing a subset of trauma patients with CT- or necropsy-confirmed pulmonary bullae – lesions traditionally associated with spontaneous rather than traumatic pneumothorax. These observations challenge the conventional dichotomy that categorizes pneumothorax as either purely traumatic or spontaneous. Instead, they underscore a clinically relevant overlap, where high-impact trauma may either rupture undiagnosed bullae or initiate their formation through alveolar damage, barometric shifts, or tissue tearing.

Importantly, our findings suggest that trauma may not only rupture pre-existing bullae but also play a causative role in their formation, particularly in cats with no prior respiratory pathology history. In such cases, prompt recognition of persistent air leakage and early consideration of advanced imaging, particularly CT, are essential for timely surgical decision-making.

Surgical intervention, primarily via lung lobectomy using endoscopic staplers, was associated with excellent outcomes in the majority of cases, including patients with concurrent contusions or haemothorax. The postoperative mortality rate was low, and survival exceeded 80% in the surgical group. Conversely, nonsurgical fatalities – confirmed to have bullous lesions postmortem – emphasize the potential consequences of diagnostic delay or underestimation of structural lung pathology. This study also highlights the critical importance of vigilant ICU management in cases of persistent pneumothorax. Continuous monitoring of respiratory patterns and subtle changes in dyspnoea is essential. Strict adherence to stabilization protocols and clinical decision-making pathways cannot be overstated – any deviation in an already fragile patient may tip the balance toward rapid decompensation and

mortality. Ultimately, our study reinforces the importance of individualized, image-guided management strategies in feline thoracic trauma. Early identification of high-risk cases, integration of CT findings, and willingness to escalate to surgical treatment where indicated can significantly improve outcomes in this fragile patient population.


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## CONFLICTS OF INTEREST

The author declares no conflicts of interest related to the content of this study.


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