APPLICABILITY OF THORACIC NON-CARDIAC ULTRASONOGRAPHY IN THE DIAGNOSTIC PROTOCOL OF ACUTE DYSPNOEA IN FELINE PATIENTS

Andreea Cătălina TURCU[1], Radu Andrei BAISAN[1], Eusebiu Ionuț CONDURACHI[1], Vasile VULPE[1]

Corresponding author: Andreea Cătălina Turcu catalina.andreea.turcu@gmail.com

Abstract

Lung ultrasonography (LUS) is a non-invasive and rapid method used for the diagnostic of respiratory diseases in all mammals. The changes in clinically observed respiratory patterns can be correlated with the modifications observed during transthoracic ultrasonography, thus the clinician can select an appropriate protocol for managing the animals with respiratory distress. The aim of this study is to emphasize the clinical utility of lung ultrasonography when dealing with cats in an emergency setting. Cats presented with respiratory distress were retrospectively reviewed and classified based on the aetiology of the disease. Lung ultrasonography was performed using the thoracic fast protocol (T-FAST). Vet BLUE ultrasonography and chest radiography were performed only when the clinical status of the patient was suitable for these diagnostic methods. Thirty-nine cats met the inclusion criteria. The presence of free fluid, B-lines, shred sign, nodule sign, organ sign and barcode sign have been assessed for each patient. Based on the findings, a differential diagnostic and a management protocol had been proposed. Lung ultrasonography is a non-invasive, stress-free and fast examination with high sensibility and specificity for diagnosing cats with breathing difficulty.

Key words: lung ultrasonography; dyspnoea; acute respiratory distress; T-fast; B-lines;

INTRODUCTION

Shortness of breath is one the most common causes of emergency presentation. Dyspnoea is an unspecific clinical sign associated with increased breathing rate and changes in the respiratory pattern. It is often a marker of significant underlying disease, therefore requires prompt treatment. Investigations performed to discover the underlying aetiology must be balanced with the status of the animal, as stress can be detrimental in these patients (Tseng L. W., 2000).

Ultrasonographic examination of the lung has been described in both human and veterinary medicine, with targeted point-of-care protocols for obtaining a fast diagnostic. Two point-of-care protocols are designed for the veterinary patients: the Thoracic Focus Assessment with Sonography for Trauma protocol (T-FAST) and the Veterinary Brief Lung Ultrasonography Examination protocol (Vet BLUE). Both protocols were designed with two precise, different purposes. T-FAST protocol monitors the presence of free fluid (pleural effusion, pericardial effusion and cardiac tamponade) and air (pneumothorax), whereas the Vet BLUE protocol evaluates the regional lung parenchyma (recommends an assessment system for the presence of B and A lines, as well as other changes located on the periphery of the lung lobes) (Lisciandro G. R., 2011; Lisciandro G. R., 2017).

The T-FAST technique evaluates the changes occurring in four main points at the level of both sides of the chest, guided by the principle that "air rises and liquid descends". The right and left chest tube sites (CTS) are assessed for the presence of gliding sign. The right and left pericardial sites (PCS) for pericardial and pleural fluid and estimation of volume status (Lisciandro G. R., 2011).

The Vet BLUE protocol aims to determine the condition's aetiology in animals with dyspnoeic syndrome. The technique involves the qualitative and quantitative assessment of the presence of A lines, B lines and lung signs (shred sign, nodule sign and tissue sign) in less than 90 seconds. This method has a high sensitivity for ruling out left-sided congestive heart failure in dogs (88%) and in cats (96%) (Lisciandro G. R., 2017).

The radiological examination of cats experiencing dyspnoea is controversial. It is well known that the patient needs to maintain a lateral, dorso-ventral or ventro-dorsal recumbence. Therefore, it is advisable to delay this procedure until the cat is hemodynamically stable or performed with the animal under general anesthesia,

[1] Clinic Departament, Faculty of Veterinary Medicine, University of Life Sciences "Ion Ionescu de la Brad", Iași, Romania

securing the airways. Regardless, the two imaging methods are complementary. The main advantage for radiologic examination is the possibility of having an overview of the thorax, including the ribcage and the profound structures.

MATERIAL AND METHOD

This retrospective observational study included cats presented for acute onset of respiratory distress at the Veterinary Teaching Hospital, between March 2021 and May 2022. Written consent for all procedures was obtained from the owners. Cats were included if the ultrasonographic evaluation of the thorax using either the T-FAST or Vet BLUE protocol was available. Patients were excluded from this study if the stored examination was incomplete.

All cats were subjected to a physical examination prior to LUS. The time of onset, breathing rate, breathing pattern and mucosal color have been assessed. If necessary, the cats received oxygen supplementation and/or opioid analgesic (Butorphanol) before and during the examination.

The ultrasound examination was carried out using two devices (General Electric LOGIQ V5 Expert ultrasound machine, equipped with a microconvex transducer 7.5-10 MHz, linear transducer 6-12 MHz and phased array transducer 2.4-8 MHz, and the SonoScape E1V ultrasound machine equipped with a microconvex transducer 4-13 MHz).

T-FAST ultrasound examination was performed without patient preparation, therefore the position of the cat remained unchanged, the fur was not trimmed and ultrasonographic gel was not applied, but CTS, PCS and hepato-diaphragmatic (HD) sites were degreased using medicinal alcohol. These steps were subsequently performed if, after the initial evaluation, thoracentesis was performed.

Vet BLUE ultrasound examination was carried out inconstantly after clipping the fur. Compared to the T-fast method, animals were examined in sternal recumbency or standing, to allow evaluation of both hemithoraxes.

Regardless of the protocol of choice, LUS was performed using a microconvex or phased array probe positioned perpendicular to the pleural space, using high frequencies in order to allow assessment of surface structures.

For each patient, the following findings in LUS had been tracked: presence of A and B lines, presence of pleural or pericardial effusion, the shred, nodule, organ and barcode sign. The A lines represent reverberation artifacts and appear horizontal, parallel, and equidistant to the pleura. They generally appear in healthy individuals, but could appear obliterated due to B lines or reinforced in pneumothorax. The B lines represent comet tail artefacts starting that appear perpendicular to the pleural line and move with the pleura during breathing. The presence of 1-2 B lines per intercostal space is normal in clinically healthy animals. Pathologically, they are associated with pulmonary edema and interstitial lung pathologies. These lines may converge, giving the appearance of a wet or white lung (Lichtenstein D. A., 2007). The shred sign is associated with consolidation and peripheric air bronchogram perceptible on radiography. The nodule sign is present when discrete nodules are consolidated or infiltrated. The organ sign indicates the presence of abdominal herniated organs in the thoracic cavity. The barcode sign is typically found in patients with pneumothorax.

Twenty-eight cats underwent radiological examination of the thorax, either before or after the ultrasonographic evaluation, in order to obtain an overview of the thoracic cavity. The X-ray examination has been included in the study if at least two orthogonal chest images had been obtained. Chest X-rays have been performed using two machines, DR MAXIVET 400HF and Intermedical Basic 4006 equipped with mobile arm using phosphor plates and the X-CR Smart Exam digital system.

RESULTS AND DISCUSSIONS

Thirty-nine cats met the inclusion criteria. The population comprised the following breeds: domestic shorthair (n=26), Persian (n=6), British Shorthair (n=3) and one of each Russian Blue, Birman, Siamese, Norwegian forest. Twenty-three cats were male and sixteen females, with unassessed reproductive status. The mean age and standard deviation of the population was 6.44±5.09 years, and the mean bodyweight and standard deviation of the population was 3.48±1.01 kg.

Based on the aetiology, the patients have been divided into six groups, as following: traumatic conditions (25.64%; n=10), primary cardiological disorder (28.2%; n=11), primary respiratory disease (12.82%; n=5), neoplastic disease (25.64%; n=10) and unknown aetiology (7.69%; n=3). The latter group consists of animals that had incomplete history, animals whose owners declined further investigations or animals that had succumbed prior to complete the required investigations. Nonetheless, these patients were not excluded from the study, but rather express a limitation regarding the accessibility for advanced diagnostic imaging, such as endoscopy or Computed Tomography (CT).

The correlation between the aetiology and dyspnoeic syndrome in cats is consistent with the literature. To the author's best knowledge, there is only one study assessing the aetiology of the dyspnoeic syndrome in cats presented in an emergency setting, which concludes that the most common associated diseases are cardiac diseases

(37.7%), primary respiratory diseases (32.2%), neoplastic (20%) and traumatic conditions (8.9%) (Swift S., 2009).

The T-FAST protocol was used for hemodynamically unstable cats, sometimes simultaneously with the performance of other necessary medical procedures in order to stabilize the animal, such as pleurocentesis. If the initial examination detected the presence of B lines, the Vet BLUE protocol was implemented. For hemodynamically stable patients a complete LUS was performed. The T-FAST protocol were performed according to the initial recommendations (Boysen S. R., 2013). Changes introduced in the authors' last article (Lisciandro G. R., 2021) were evaluated when the Vet BLUE protocol was performed or during the cardiological examination. As the point-of-care protocols became more popular, the feasibility of the methods became uncontestable. However, the multitude of steps included in the T-FAST protocol distract the examiner from to the original purpose of the examination method, they complicate the working method and lengthen the examination time, which could be detrimental when dealing with dyspnoeic cats.

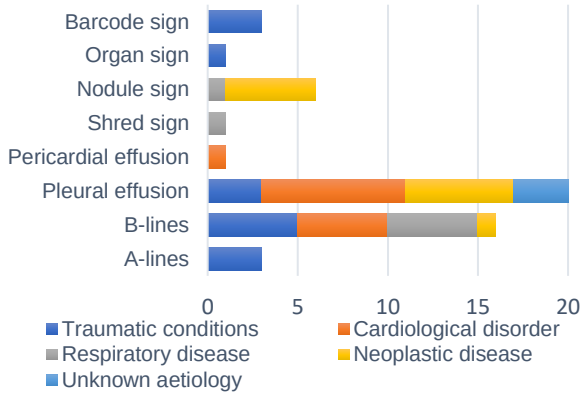

Figure 1 – Graphical representation of ultrasonographic findings in association with the aetiology of the disease

The correlation between LUS findings and aetiology for the studied population is depicted as stacked bar chart in *figure 1*.

The patients included in the trauma group revealed either normal findings during T-FAST (30%) or pathological findings, such as B-lines as a result of pulmonary contusion (50%), pleural effusion due to hemothorax (30%), barcode sign due to pneumothorax (30%) and organ sign due to transdiaphragmatic hernia (10%) (*figure 2*). The trauma resulted in unknown conditions (n=4) or due to free fall (n=2), dog bites (n=2) and hit by car (n=2).

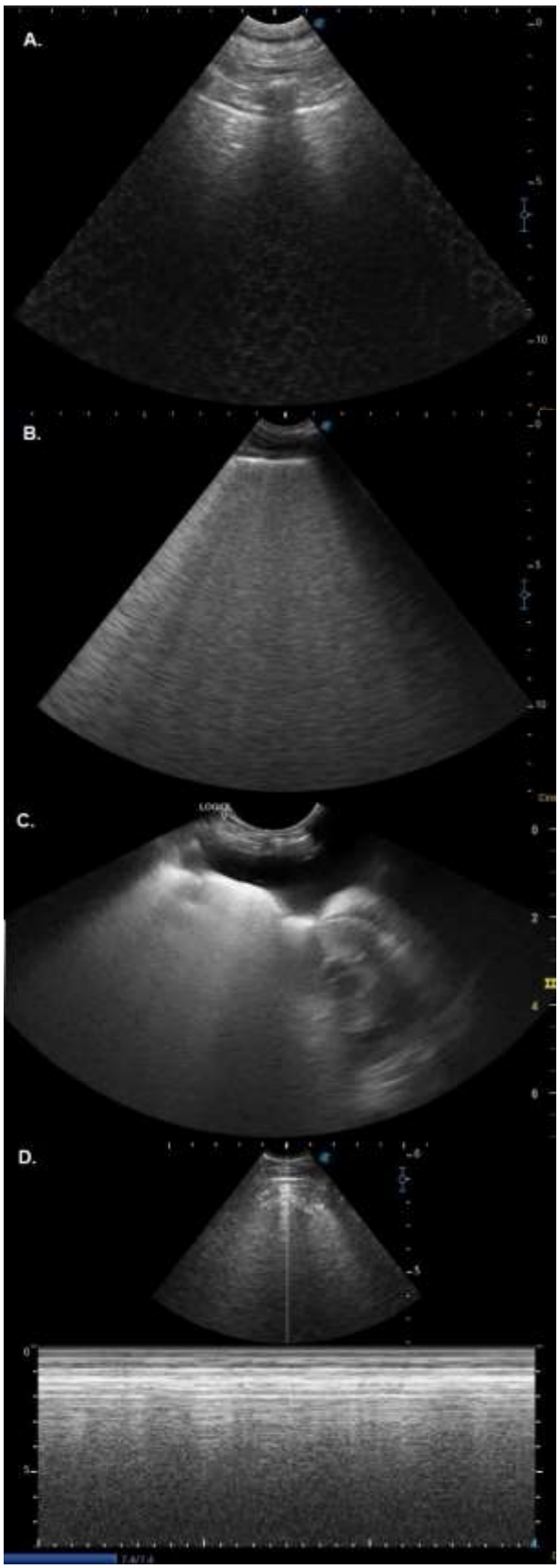

Figure 2 – LUS findings in trauma patients. A – A lines; B – B lines; C – pleural effusion; D – barcode sign;

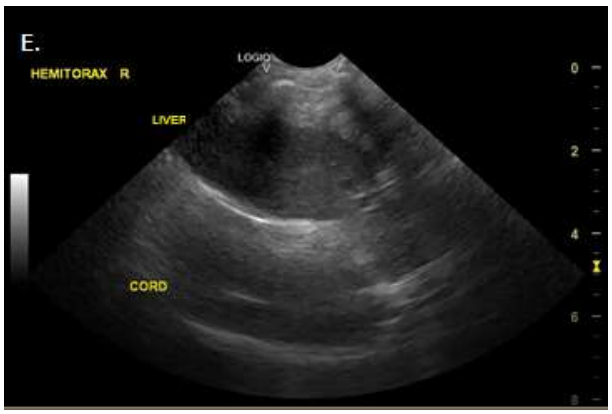

Figure 2 – LUS findings in trauma patients. E – organ sign.

The second group consists of cats with primary cardiac conditions. LUS findings revealed B-lines associated with cardiogenic pulmonary edema (45.45%), pleural effusion (72.72%) and pericardial effusion (9.09%) (*figure 3*). All cats underwent a complete cardiological examination including cardiac ultrasonography after the initial assessment. The definitive diagnostic was feline hypertrophic cardiomyopathy (n=8) and one of each nutritional dilated cardiomyopathy and tricuspid dysplasia.

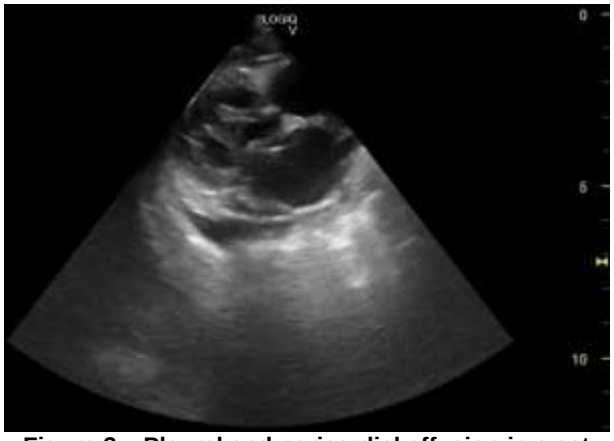

Figure 3 – Pleural and pericardial effusion in a cat diagnosed with unclassified hypertrophic cardiomyopathy.

The third group consists of cats with primary respiratory disease. The importance of point-of-care LUS for this group derives from the necessity to rapidly differentiate primary cardiogenic disorders from primary respiratory ones, as well as to identify patients with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS). ARDS is a life-threatening condition where the lungs cannot provide enough oxygen to the vital organs. ALI and ARDS are secondary disorders caused by a severe inflammatory reaction, the origin of which may be the lung or a site distant to the lung. A diagnosis is based on the presence of four main criteria: the acute onset (less than 72 hours), the presence of a primary underlying disease that causes enough inflammation to set up a reaction in the lungs, evidence of pulmonary capillary leak without evidence of increased hydrostatic pressures and evidence of inefficient gas exchange (Boiron L., 2016). The most important and practical diagnostic tests include a thorough history, thoracic radiography, echocardiography, and arterial blood gas analysis (Wilkins P. A., 2007). However, cats have the tendency to mask all clinical signs, therefore the owners will not be able to identify minor changes in the breathing rate or pattern. This results in belated presentation at the veterinarian, frequently in an emergency setting. By assessing the PCS, a differential diagnostic can be proposed prior to other more invasive diagnostic procedures that might increase the stress level of the cat and even worsen the dyspnoea, such as collecting blood samples. The LUS findings for this group revealed the presence of B-lines (100%) constantly associated with interstitial lung patterns on chest radiography, shred sign (20%) (*figure 4*) and nodule sign (20%). The definitive diagnostic was aspiration pneumonia (n=2), feline asthma (n=1), aelurostrongylosis (n=1) and one owner declined supplementary investigations. Based on the hypoxia level, one cat has been diagnosed with ALI, 3 with ARDS and one was unassessed.

Figure 4 – Severe shred sign in a cat with aspiration pneumonia

The fourth group consists of cats with neoplastic disease. LUS findings revealed pleural effusion (60%), nodule sign (50%) (*figure 5*) and B-lines (10%). The definitive diagnostic consisted of mesothelioma (n=4), lymphoma (n=2), thymoma (n=1) and three owners declined fine needle aspiration and cytological investigations.

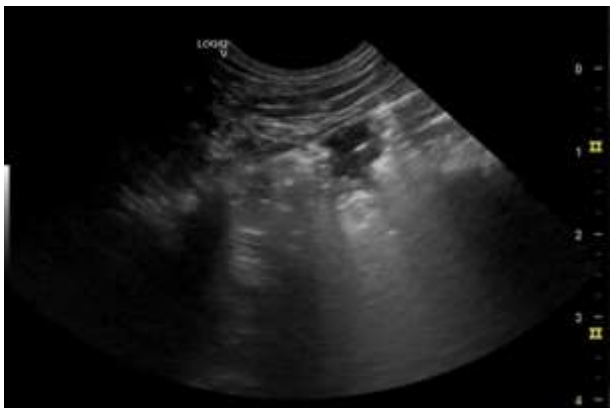

Figure 5 – Nodule sign in a cat with mesothelioma

Three cats have been presented with pleural effusion of unknown aethiology. No other abnormal findings have been detected with LUS of chest radiography. Pleurocentesis was performed, revealing transudate in two cats and chylothorax in one. The owners declined further investigations.

Chest radiographies have been obtained for twenty-eight cats using standard protocols. The localizations of abnormal findings are shown in *figure 6.*

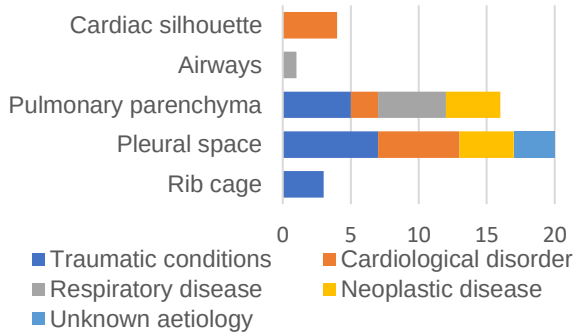

Figure 6 – Graphical representation of affected anatomical segments diagnosed using X-ray in association with the aetiology of the disease

The fact that most of the abnormalities have been associated with the pulmonary parenchyma and pleural space in dyspnoeic cats is thus not surprising. The ultrasonographic examination has increased sensitivity when assessing these segments (Richards J. R., 2017), therefore their description was not considered an objective of this paper. However, the importance of obtaining an overview of the thorax is underlined by pathologies associated with the rib cage, airways or cardiological diseases.

Three cats with thoracic trauma had multiple rib fractures. For these patients, pain management has been implemented in order to increase the patient comfort and decrease the respiratory stress. One cat with primary respiratory disease revealed severe bronchial pattern on X-ray. Due to the fact that ultrasounds can only assess the superficial structures of the thorax, this method is limited in diagnosing airway disease. Thoracic radiography is insensitive for identification of mild or moderate cardiac changes associated with feline cardiomyopathy (Virginia Luis Fuentes, 2020). However, severe cardiomegaly was observed in four cats.

CONCLUSIONS

Lung ultrasonography is a non-invasive, stress-free and fast examination method with high sensibility and specificity for diagnosing cats with difficulty breathing. Based on the findings, a suitable management protocol can be implemented and a differential diagnostic can be obtained.

ACKNOWLEGMENTS

This research received no external funding.
The authors report there are no competing interests to declare.

REFERENCES

Boiron L., H. K. (2016). *Risk factors, characteristics, and outcomes of acute respiratory distress syndrome in dogs and cats: 54 cases.* Veterinary Emergency and Critical Care, 1-7. doi:10.1111/vec.12819

Boysen S. R., L. G. (2013). *The use of ultrasound for dogs and cats in the emergency room: AFAST and TFAST.* Veterinary Clinics of North America: Small Animal Practice, 773-797.

Lichtenstein D. A. (2007). *Ultrasound in the management of thoracic disease.* Journal of Critical Care Medicine, S250-S261.

Lisciandro, G. R. (2011). *Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals.* Journal of Veterinary Emergency and Critical Care, 104-122.

Lisciandro, G. R. (2017). *Vet BLUE® Lung Ultrasound in Small Animals - The New Way to Do Respiratory Distress.* Southwest Veterinary Symposium. Spicewood, TX, USA.

Lisciandro, G. R. (2021). *Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals.* Journal of Veterinary Emergency and Critical Care, 104-122.

Richards J. R., M. J. (2017). *Focused Assessment with Sonography in Trauma (FAST) in 2017: What Radiologists Can Learn.* Radiology, 30-48.

Swift S., D.-M. J. (2009). *Aetiology and outcome in 90 cats presenting with dyspnoea in a referral population.* Journal of Small Animal Practice, 446-473.

Tseng L. W., W. L. (2000). *Approach to the patient in respiratory distress.* Clinical Techniques in Small Animal Practice, 53-62.

Virginia Luis Fuentes, J. A. (2020). *ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats.* Journal of Veterinary Internal Medicine, 1062–1077.

Wilkins P. A., O. C. (2007). *Acute lung injury and acute respiratory distress syndromes in veterinary medicine: consensus definitions: The Dorothy Russell Havemeyer Working Group on ALI and ARDS in Veterinary Medicine.* Journal of Veterinary Emergency and Critical Care, 333-339.