Ankara Univ Vet Fak Derg, **68**, 311-320, 2021
DOI: 10.33988/auvfd.909936

Review / *Derleme*

Novel ultrasonographic imaging technique in cat and dog intensive care patients: A-FAST^3

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Received date: 05.04.2021 - Accepted date: 25.06.2021

Abstract: Focused Assessment with Sonography for Trauma (FAST) and Veterinary point-of-care ultrasonography (POCUS) are fast ultrasonographic diagnostic tools developed to discover pathologies in trauma patients in veterinary medicine and direct veterinarians to accurate treatment plans. Aside from detection, scoring and treatment protocol establishment in traumatic and non-traumatic hemoabdomen cases, AFAST (abdominal FAST) sonography is used effectively to define anaphylaxis, pericardial effusions and cardiac tamponade and pleural effusion symptoms. This technique when implemented every 4 hours for 3 to 5 minutes assists in identification of patient prognosis and treatment protocols through focused imaging.

With this review, we aimed to explain and deliver in detail indications for AFAST^3 technique, know-how and clinical benefits for trauma patients.

Keywords: A-Fast, diagnostic imaging, emergency protocols, ultrasound.

Kedi ve köpek yoğun bakım hastalarında yeni ultrasonografik görüntüleme tekniği: A-FAST3

Özet: Focused Assesment with Sonography for Trauma (FAST) ve Veterinary point-of-care ultrasonography (POCUS), veteriner hekimlikte travma hastalarında patolojileri çabuk bulma ve yol göstermek için geliştirilmiş, hızlı ultrasonografi tanı yönlemleridir. AFAST (abdominal FAST) ultrasonografi yöntemi ile travmatik ve travmatik olmayan hemabdomen durumlarının belirlenmesi, skorlanması ve sağaltım protokolünün oluşturulması dışında, anafilaksi, perikardiyal efüzyonlar ve kardiak tamponad, plevral efüzyonun belirtilerinin de belirlenmesinde etkin şekilde kullanılmaktadır. Her 4 saatte, 3-5 dakikalık odaklanmış (focused) görüntüleme ile hastanın prognozu ve sağaltım protokollerinin belirlenmesine yardımcı olur.

Bu yazıda, AFAST^3 tekniğinin hangi durumlarda kullanıldığını, nasıl yapıldığını ve travma hastalarına klinik faydalarını detaylı şekilde aktarmayı amaçladık.

Anahtar sözcükler: A-Fast, acil protokolleri, diagnostik görüntüleme, ultrason.

Introduction

Doctors in human medicine have been conducting ultrasonographic assessments in trauma patients since the 1980s (11). FAST (focused assessment with sonography for trauma) was studied in detail in the early 1990s and has developed to be the diagnostic tool of choice for assessment of free fluid in peritoneal and pleural cavities (25), followed by a study performed to determine pneumothorax, pleural and pericardial effusions in thoracic trauma (E-FAST) (13). New intensive care protocols have been developed (FAST-ABCDE) in order to determine respiratory and circulatory disorders and airway obstructions more urgently (31). In line with these advances in human medicine, it is considered a necessity to establish fast diagnostic protocols to identify pathologies in trauma patients in small animals.

Focused assessment with sonography for trauma (FAST) has been identified prospectively by Boysen in 2004 in dogs with trauma (3). Boysen has reported with this study that intraabdominal traumas, particularly hemoabdomen occur more frequently despite previous studies. Lisciandro has supported Boysen's findings with a similar study he conducted on dogs. These two authors have used the term A-FAST (abdominal FAST) for the fast sonography scanning technique they have developed for trauma patients. They have named the technique

performed for the thoracic region in order to better identify this fast scan as T-FAST (thoracic FAST) (21). Authors preferred and globalized these abbreviations to avoid any possible confusion with similar terms in human medicine. Again in 2009 Lisciandro has performed intraabdominal hemorrhage assessment using this scanning technique every 4 hours in all hospitalized dogs beginning from their initial evaluation and established a scoring system. With this study, he was able to differentiate small size hemorrhages from traumas with serious blood loss (22).

With the same study, AFAST has been considered an excellent diagnostic method to determine hemorrhages occurring during the following process in patients with no initial intraabdominal bleeding. Based on the results of scoring, it was possible to evaluate developing anemia in patients with severe blood loss and present their need for blood transfusion or an exploratory laparotomy with this novel diagnostic method (22).

Researchers have compared their results with the research of 2011 to form a triage system by determination of the need for blood transfusion in dogs with hemoabdomen, or by regulation of present fluid therapy protocol (15).

AFAST sonographic technique lasts approximately 3 to 5 minutes and other than determination, scoring, and treatment protocol establishment of traumatic or non-traumatic hemoabdomen cases, it is also facilitated effectively for identification of anaphylaxis, pericardial effusions and cardiac tamponade, pleural effusion. This technique is not performed only for trauma, but its diagnostic value for critically ill dogs or cats has also been demonstrated (27). Based on all these reasons, current terminology as AFAST has been converted to AFAST^3. "T^3" represents AFAST use for trauma, triage, and tracking (6, 17).

What does AFAST^3 ultrasonography method provide us?

AFAST^3 can detect free fluid even in small quantities superior to physical examination and abdominal radiography techniques, on a level equal to computed tomography (CT) which is accepted as the golden standard (40).

- Predicts the degree of anemia following trauma in patients with no previous apparent anemia by performing an abdominal fluid scoring (AFS). Low levels of bleeding are scored as AFS1 and AFS2, whereas severe blood accumulations are scored as AFS3 and AFS4.
- Using the same scoring provides information regarding the degree of anemia formation in non-trauma patients with hemoabdomen (ruptured spleen, coagulopathy, etc.).
- Scoring is possible after checking the development of any effusion in postoperative period controls (complications such as peritonitis) (2, 22).
- While performing an assessment through diaphragm-liver window, pericardial and pleural effusions with clinical significance do not go unnoticed. Changes in gall bladder indicative of anaphylaxis can be defined and possible hepatic venous tension and right heart pathologies can be noticed even with the evaluation of estimated caudal vena cava size (2, 33).

Most importantly, with this assessment performed every four hours which lasts only for 3 to 5 minutes, sensitivity to the patient increases, and any possible pathology can be detected at the very beginning of the process (2).

What is not possible to achieve with AFAST^3 and AFS scoring?

- We cannot determine free fluid characteristics; therefore, it is obligatory to perform an ultrasound-guided abdominocentesis to obtain a sample for analysis.
- Scoring is not objective in penetrating traumas in contrast to blunt traumas. Degrees of anemia can be deceiving.
- Can be insufficient to the determination of the degree of anemia in cats with trauma because in cats the source of free fluid can be urine due to a ruptured bladder (2).

When we should perform AFAST^3?

- As standard assessment of intraabdominal free fluid in all patients with blunt trauma
- In patients with unexplained hypotension, tachycardia and mental alterations
- All patients with anemia
- Cases with risk of hemorrhage following surgery and biopsy
- Patients with risk of peritonitis
- Cases requiring abdominocentesis (2).

How to perform AFAST^3 sonography method

Ultrasonographic method and probe preferences: Convex, micro convex, or linear probes with a range of 5–10 MHz are suitable. For cats, linear probes, and particularly for especially large breed dogs, convex probes should be selected. These selections for sure change based on the ultrasound machine at hand and size of the patient, however ultrasound machine gain (d2) is set to 70%. This adjustment enables imaging even in the light environment (2, 3).

Patient positioning: Hair is usually not trimmed alcohol and ultrasound gel are sufficient. However, in patients with heavy fur such as Anatolian Shepherds and

Siberian huskies, trimming may be needed. Image quality may be enhanced in these patients with small trimming points (15, 22). If it is anticipated to use a defibrillator in a patient, alcohol use must be avoided. Otherwise, severe burns may occur. In addition, it must be kept in mind that alcohol use will cause damage on probe tips in elongated periods.

The patient is assessed on lateral recumbency. There is no difference in practice among patients in right lateral or left lateral recumbency. However, if electrocardiographic and echocardiographic examinations will also be performed on the patient, right lateral recumbency position is more suitable. Left kidney, gall bladder, and bladder assessment are more comfortable in patients in right lateral recumbency. Again, in this position, abdominocentesis is safer because the spleen is anatomically located on the left side of dogs and cats (2, 18).

- Modified sternal position can also be preferred in stressed patients where it is difficult to create lateral recumbency. In dorsal recumbency, acoustic windows used in AFAST assessment cannot be facilitated correctly, therefore free fluid cannot be assessed accurately. In these cases, AFS scoring is misleading. Again, in patients with respiratory distress, dorsal recumbency can elevate stress (15, 37).

AFAST[3] window nomenclature: AFAST examination is performed by assessment of diaphragm, liver, gall bladder, spleen, kidneys, intestinal segments, and bladder circumference in order to detect free fluid in the peritoneal cavity (2).

Free fluid is anechoic and is detected around organs as independent black areas. Assessment usually begins with the diaphragm and continued clockwise in the right lateral recumbency patient (28).

1. Diaphragmatic-hepatic (DH) window
2. Spleno-renal (SR) window
3. Cysto-colic (CC) window
4. Hepato-renal (HR) window, assessment is concluded with this window and this window is the most appropriate window for abdominocentesis.

To start the assessment, a probe marker is placed into the sonographic window in a manner to locate cranially. This is how longitudinal assessment is performed and then the probe is turned to right 90 degrees to realize a transversal scan. Longitudinal assessment is solely successful and sufficient to evaluate fluid presence (3).

Diaphragmatic-hepatic window (DH): Place probe under subxiphoid (Figure 2). Enhance image depth in the ultrasound machine. The objective in this window is to observe fluid accumulation between the liver and diaphragm. The liver is in contact with the diaphragm in a healthy animal. If there is fluid present, an anechoic line is observed between these two structures (Figure 3).

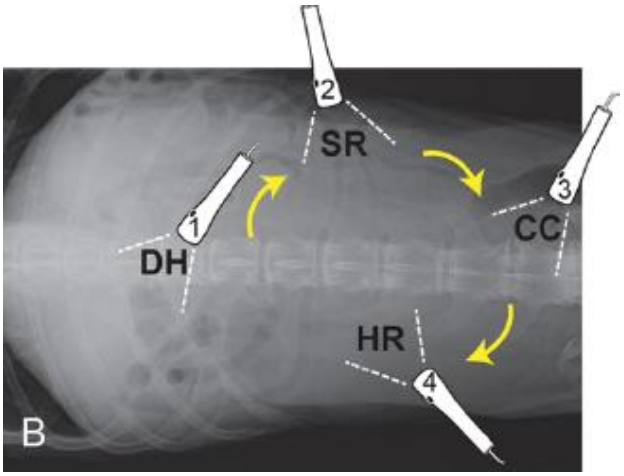


Figure 1. Ultrasonography views for Afast. DH= diaphragmatic-hepatic view, SR= Spleno-renal view, CC=cystocolic view, HR= hepato-renal view (2).

Figure 2. Placement of probe for diaphragmatic-hepatic window.

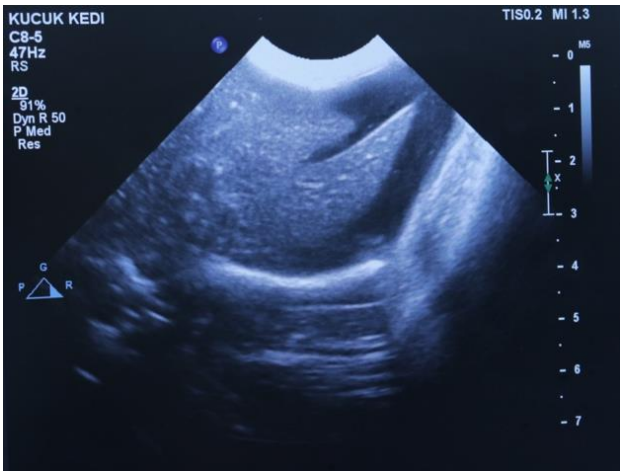


Figure 3. Diaphragmatic-hepatic window showing liver (L), diaphragm (D) and large amounts of interposed peritoneal effusion (E).

Gall bladder, caudal vena cava, pleural and pericardial cavities are also assessed through DH window (16, 20). The gall bladder is located between the right median and quadrate lobes of the liver in dogs, and in the right median lobe right to linea alba in cats. In normal gall bladder of dogs and cats appears as an anechoic, thin-walled, oval-round structure.

Gall bladder shape and structure must be noted. In cases where it is not possible to visualize the gall bladder, it must be kept in mind that a rupture may be present, as well as a dislocation as a result of a diaphragmatic hernia.

Small quantities of fluid are typically located in between the liver and diaphragm and also liver lobes. Even though a marked free fluid is absent between the diaphragm and liver, attention must be paid to fluid presence between lobes. Following fluid presence assessment between diaphragm and liver, evaluate thoracic cavity by enhancing ultrasound machine depth. Pleural and pericardial effusions can be identified through this window.

In a clinical study, it was demonstrated that 88% of pericardial effusions can be identified through DH window (16). However pericardial effusion, pleural effusion, and dilated cardiomyopathy (DCM) images may be melded in this window image. Any interventional centesis procedure must be avoided solely based on DH window image. Once fluid presence is determined in the thoracic cavity, thorax examination for such patient must be continued through the thoracic cavity (with T-FAST method). Thorax imaging may not always be possible due to the depth insufficiency of ultrasound machines used in large animals.

Finally, caudal vena cava (CVC) diameter can be subjectively evaluated and hepatic venous distension is identified. CVC wall is observed as two parallel echoic lines and resembles a big “equal to” mark. Hepatic veins are present in the liver as branches of CVC (8, 12, 30). If hepatic veins are observed large like tree branches, right heart failure, obstructive pathologies between right atrium and liver, caval syndrome, Budd-Chiari-like syndrome, and pathologies like liver cirrhosis must be considered (1, 9).

There are also artifacts while assessing DH window which can mislead the veterinary surgeon. The sound wave is refracted while passing through a solid tissue like a diaphragm to a thoracic cavity filled with gas and causes the appearance of an identical reflection of an image in the abdominal cavity in the thorax (mirror artifacts). This condition can cause false positive scoring or false diagnoses such as pleural effusion and diaphragmatic hernia (4, 26, 32).

Veterinary surgeons in charge of sonography must not forget that these artifacts may occur. Occasionally side lobes of the gall bladder can reflect inside the gall bladder (side-lobe artifacts) and can cause images as if there is mud or sedimentation within. In order to avoid this situation, slightly change probe angle and re-evaluate inside of gall bladder.

Figure 4. Probe position for Spleno-renal window.

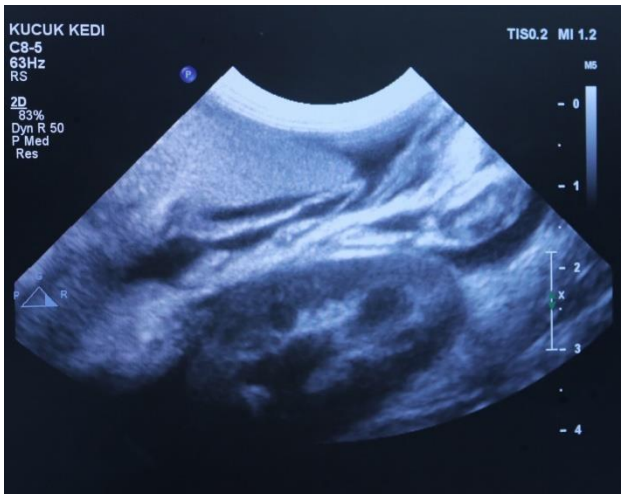


Figure 5. An image of effusion evaluated from Spleno-renal penrece. LK = left kidney, E= effusion.

Spleno-Renal window (SR): Spleno-renal (SR) window demonstrates the presence of free fluid both around the spleen (peritoneal cavity) and left kidney (retroperitoneal cavity). The probe is positioned caudal to final rib and ventral to lumbar hyperaxial muscle to form a long axis image. Anechoic areas around the kidney or spleen, but generally between small intestine segments represent effusion (Figure 5). the presence of a cavity mass

in this area usually indicates spleen tumors (23). It may pose some difficulty to differentiate small fluid accumulations right adjacent to the kidney as peritoneal or retroperitoneal. Retroperitoneal fluid at this particular area must raise doubts for hemorrhage, urine, and sterile and septic effusions (17).

Large veins (aorta and caudal vena cava) progressing immediately medial to left kidney should also be assessed through SR window. Veins are observed as anechoic areas in between hyperechoic straight lines. The probe is turned counter-clockwise to see transversal cross-sections of veins that appear as anechoic areas. If the probe is held in a stationary position, pulsation in the aorta can be easily noticed.

Colon localizes to the right side in a right lateral recumbency patient, which facilitates spleno-renal area assessment. In very small cats, the right kidney can also appear in the image during assessing the left kidney. It must be acknowledged by the veterinary surgeon in charge of sonography that this image is not a mirror artifact (32).

Cysto-Colic window (CC): Cysto-colic (CC) window aims to detect free fluid presence in Greg pouch positioned between urinary bladder and ventral wall. In small-volume effusions when CC window score is positive, fluid accumulation in a triangle shape is observed between urinary bladder apex and ventral abdominal wall (Greg pouch). In large volume fluid accumulations, fluctuation movement of small intestines and omentum in free fluid is observed. This is one of two windows that generally present a positive outcome in small volume fluid accumulations (the other is DH window).

One should be careful during assessment when moderate fluid accumulation is present around the urinary bladder. The anechoic fluid image both inside the urinary bladder and around can cause refraction artifact and result in obstruction of visualization of a part of the urinary bladder wall. This may be falsely interpreted as a urinary bladder rupture. Urinary bladder wall integrity must be assessed in multiple different angles, and it must be kept in mind that the urinary bladder sustains a collapsed appearance in ruptures (2, 32).

Hepato-Renal window: Hepatorenal (HR) window is a relatively difficult window for assessment especially in large breed dogs. The probe must be directed to the table, which means ventral direction in patients with right lateral recumbency (Figure 8). Right kidney is located in caudate lobe of liver in fossa renalis in dogs; in cats, is typically separated from caudate lobe of liver with retroperitoneal fat. Right kidney is generally positioned more cranially and laterally compared to left kidney. Therefore, it may defy imaging right kidney and liver juncture in large breed dogs (15, 22).

Figure 6. Positioning of probe for cystocolic acoustic window.

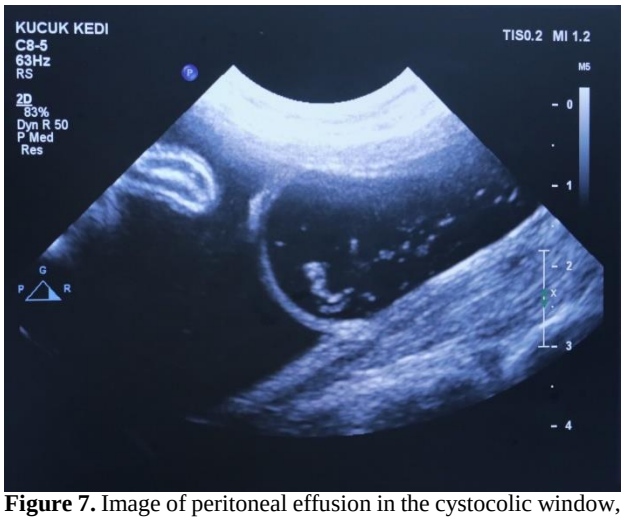


Figure 7. Image of peritoneal effusion in the cystocolic window, UB= bladder, C= colon pattern, e= peritoneal effusion.

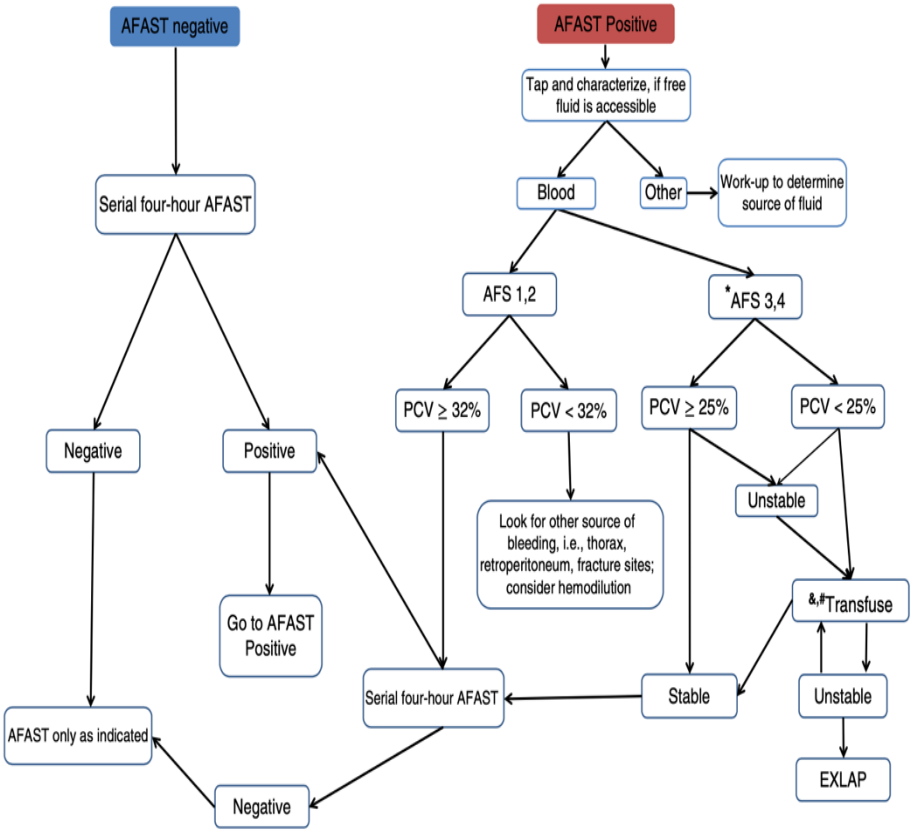
Figure 8. Position of probe for Hepatorenal acoustic window.

Table 1. Goal-Directed Template for AFAST[3] (18).

Patient positioning	Right or left lateral recumbency	
Gallbladder	Present or absent, contour (normal or not) and wall (normal or not)	
Urinary bladder	Present or absent, contour (normal or not) and wall (normal or not)	
Diaphragmaticohepatic view	Pleural fluid	Present or absent (mild, moderate, severe) or indeterminate
	Pericardial fluid	Present or absent (mild, moderate, severe) or indeterminate
	Hepatic veins	Unremarkable or distended or indeterminate
Positive or negative at the four views (0 negative, 1 positive)		
Diaphragmaticohepatic site	0 or 1	
Splenorenal site	0 or 1	
Cystocolic site	0 or 1	
Hepatorenal site	0 or 1	
Abdominal fluid score: 0–4 (0 negative all quadrants to a maximum score of 4 positive all quadrants)		
Comments: _____.		

The AFAST[3] examination is an ultrasound scan used to detect the presence of free abdominal fluid and other conditions to better direct resuscitation efforts and patient care. AFAST[3] allows indirect assessment for evidence of intra-abdominal injury or disease and intrathoracic injury or disease. The AFAST[3] examination is not intended to replace a formal abdominal ultrasound.

Table 2. Decision-making algorithm for dogs correlating the abdominal fluid score to the anticipated degree of anemia in bluntly traumatized and post-interventional (surgery, percutaneous biopsy, laparoscopy) canine cases (2).



Fluid presence between liver and kidney indicates retroperitoneal and peritoneal effusion (Figure 9). While scanning this particular area, fluid presence is investigated rather than focusing on liver and kidney. It has been reported that scans performed with the transversally positioned probe are more effective in detecting free fluid (22). Scanning is concluded with this window. Even mild volumes of fluid can be observed through this window under influence of gravity. If abdominocentesis is in question, it is generally performed with guided sonography through this window (2).

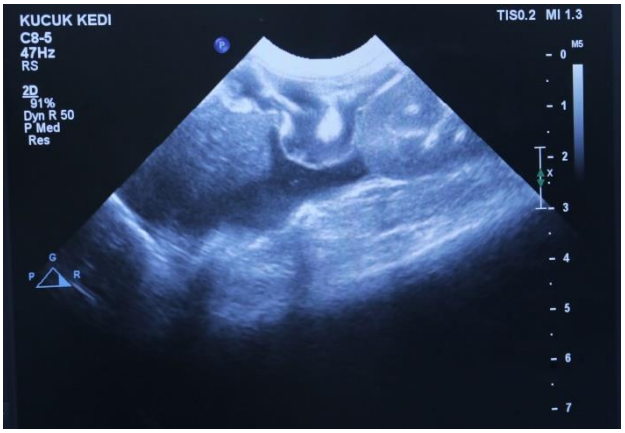


Figure 9. Peritoneal effusion image from Hepatorenal acoustic window. RK= right kidney, L= liver, * = peritoneal efüyon.

In cases where it is necessary to image right kidney, recumbency position is converted to dorso-lateral in small-size dogs and cats. In cases where it is not possible to assess the kidney, the dog is positioned to left lateral position as in larger breed patients.

How to perform Abdominal Fluid scoring (AFS)?

Although the abdominal fluid scoring system is used predominantly for hemoabdomen assessment, urine or bile can also be present as free fluid, therefore fluid scoring terminology is deliberately used.

Following is how AFS scoring is done; each window has 1 point. If all windows are negative, 0, if all of them are positive, maximum AFS is scored 4 (10, 22).

AFS evaluation in dogs: In dogs, AFS 1 and 2 represent small and AFS 3 and 4 severe hemorrhages. In dogs with AFS scored 1 and 2, if there is no previous anemia and hemorrhages if AFS score remains 1 or 2 in the assessment series (A-FAST once every 4 hours), these patients do not develop severe anemia. No blood transfusion or exploratory laparotomy is required. in more recent research, scores 1 and 2 have been categorized for very small amounts of liquids (19). The patient's condition is regarded as stable. In cases where packed cell volume (PCV) is less than 30%, and if there is no history of known anemia, the veterinary surgeon must focus on lungs and fracture sites for hemorrhage. If AFS is 3 and 4, there is no previous anemia and PCV is less than 25% blood transfusion or exploratory laparotomy is needed (3, 22, 38). It is mandatory to assess such patients surgically.

Boysen and Lisciandro have published a decision tree associating abdominal fluid score to the anticipated degree of anemia.

Clinical Significance of Abdominal Fluid Scoring (AFS) in Cats: In an assessment conducted with 49 trauma-cats, no clear connection between anemia and AFS score was identified, as was contrary in dogs (16). However; cats with hemoabdomen appear less than dogs. The reason for this is that cats have a much smaller chance of survival after car accidents compared to dogs (24). In cats with identified free fluid, the possibility of said free fluid to be urine is as high as blood.

Abdominal Fluid Score Use in Non-Traumatic cats and dogs: In non-trauma cats and dogs, abdominal fluid accumulation may occur following organ ruptures, coagulopathy (active bleeding) or surgical operation-biopsy processes and AFS can be facilitated in such patients as well. In the determination of such abdominal bleeding, AFAST^3 is much more reliable and a lot faster compared to laboratory findings (PCV), physical examination outcome, and radiography (22, 35, 36). In contrary to dogs, the prognosis for non-trauma hemoabdomen is generally bad in cats (7) and therefore AFS credibility in cats is yet to be established.

AFAST^3 can be used both in dogs and cats as an auxiliary tool to assist in physical examination for early diagnosis of hemorrhage and other complications. AFAST success regarding this particular issue has been well documented in human medicine (35, 36). Initial AFAST^3 application and series of examinations to establish an AFS score will aid in the early identification of the amount of hemorrhage. Moreover, this technique helps to define severe bleeding and directs veterinary surgeons to perform blood transfusion or laparotomy. In humans, it has been reported that even blood loss of up to 30% of total blood volume may not show with marked clinical symptoms, and attending physicians my fall into erroneous judgement (29). Blood reserves manifest with splenic contractions in dogs and prevent the patient from displaying clinical symptoms even in severe blood losses.

Coincidental lesions are frequently observed during routine AFAST examinations. These are predominantly tumors, spleen hematoma and blood clots in the urinary bladder lumen. This condition is also reported in human medicine (14).

AFAST use in Penetrating Traumas: In a study conducted with 145 dogs with penetrating trauma, it is reported that AFAST failed to identify serious intraabdominal injury in need of surgical intervention (21). The reason for this failure lies in the nature of trauma. Blood is quickly defibered in blunt force traumas and even small amounts of blood can be detected through sonography. The tissue is crushed and torn in penetrating traumas, which enhances blood clotting. Congealed blood does not appear anechoic, rather it displays shades of grey similar to soft tissue. It is possible to miss with sonography. However, in time, congealed blood can de-fibrine and may be defined between organs with sonography. Therefore, it is recommended to use a series of AFAST examinations in penetrating traumas as well. In addition, in penetrating cases where AFAST is positive, the patient needs an emergency laparotomy (13, 25, 39). The evaluation must continue for 12-24 hours, every 4 hours after patient admission.

AFAST use in anaphylaxis in dogs: Anaphylaxis is a condition that requires different medical treatment in dogs (5, 10, 34). In 2009, clinical use of ultrasound in dogs for anaphylaxis diagnosis is documented and it has been shown of service. Since shock organs in dogs are the liver and gastro-intestinal system, hepatic venous congestion (in a few seconds experimentally) immediately occurs with massive histamine release in portal circulation (33). As a result, gall bladder wall is thickened and a double-layer wall image appears.

This pathology in gall bladder wall develops much faster (less than two to four minutes) than shock indicators such as alanine transaminase (ALT) level (peak level in two to four hours). This alteration in gall bladder is called “halo sign” (33). It must be acknowledged that other factors including conditions that cause venous and lymphatic obstruction such as cardiac tamponade and congestive heart failure will manifest in halo sign appearance (normal thickness in dogs is less than 2-3 mm); Halo sign can be noticed in diseases affecting regional anatomy such as pancreatitis, cholangiohepatitis and primary gall bladder pathologies, severe hypoalbuminemia and excessive resuscitation (30).

In addition to halo signs in dogs with anaphylactic shock, fluid accumulation generally with low AFS score (AFS1 or AFS2) is noticed through DH window. Although rarely, AFS 3 and AFS 4 can also be detected. Ensuring the presence of anaphylaxis at this point will avoid a false experimental laparotomy. Clotting time increases, ALT levels are significantly high and hemoconcentration is detected in anaphylaxis (5).

It is crucial to determine whether the patient with halo sign has anaphylaxis or cardiac tamponade. Once halo sign is noticed in the gall bladder, it is recommended to perform an obligatory heart examination (with T-FAST). Because if treatment is initiated assuming the presence of anaphylaxis, but actually there is cardiac tamponade, this treatment may prove to be fatal (20, 30).

AFAST^3 use and DH appearance for Pericardial Effusions: DH window provides a good acoustic window to image the heart. To monitorize the apical aspect of the heart in cats and in small to medium-size dogs, the depth and focus of the ultrasound machine must be adjusted. Pericardial effusion appears as a thin line of anechoic area around the cardiac apex. Using only this window, it may not be possible to differentiate between pericardial and pleural effusion; that’s why when pleural and pericardial effusion is present, T-FAST examination is a must in dogs or cats (17).

Conclusion

AFAST^3 is a sonographic imaging technique more superior to other imaging methods due to its ability to provide rapid information associated with patient prognosis and to direct the surgeon to more accurate treatment.

- A-FAST must routinely be used in cats and dogs with blunt traumas in addition to clinical examination.
- Examination duration must be limited to 3-5 minutes.
- Series of AFAST examinations in trauma patients must always continue in 4-hour intervals starting from patient admission. Including peritonitis cases, following re-hydration and resuscitation of patients with penetrating trauma and patients with non-trauma risk, A-FAST assessment must be initiated and be followed for 12-24 hours.
- AFS system utilization is effectively applicable for hemorrhage in traumatized and non-traumatized dogs to estimate the degree of anemia (not reliable in cats). In addition, it can be a tracking tool for peritonitis or other effusive cases.
- Thoracic assessment should be carried out with T-FAST in patients with pericardial or pleural effusion.
- Anaphylaxis diagnosis in dogs may be supported with a gall bladder halo sign; however, one must ensure that there is no cardiac tamponade-mediated halo sign.

References

1. **Bayraktar UD** (2007): *Hepatic venous outflow obstruction: Three similar syndromes*. World J Gastroenterol, **13**, 1912.
2. **Boysen SR, Lisciandro GR** (2013): *The Use of Ultrasound for Dogs and Cats in the Emergency Room*. Vet Clin North Am Small Anim Pract, **43**, 773–97.
3. **Boysen SR, Rozanski EA, Tidwell AS, et al** (2004): *Evaluation of a focused assessment with sonography for*

trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. J Am Vet Med Assoc, **225**, 1198–1204.

4. **Browne JE** (2011): *Book Review: Sonography – Principles and Instruments (8th Edition)*. Ultrasound, **19**, 242–242.
5. **Caldwell DJ, Petras KE, Mattison BL, et al** (2018): *Spontaneous hemoperitoneum and anaphylactic shock associated with Hymenoptera envenomation in a dog*. J Vet Emerg Crit Care, **28**, 476–82.
6. **Côté E** (2015): Clinical veterinary advisor. Dogs and cats St. Louis, Missouri: Elsevier Mosby, 3rd ed.
7. **Culp WTN, Weisse C, Kellogg ME, et al** (2010): *Spontaneous hemoperitoneum in cats: 65 cases (1994–2006)*. J Am Vet Med Assoc, **236**, 978–82.
8. **Darnis E, Boysen S, Merveille A-C, et al** (2018): *Establishment of reference values of the caudal vena cava by fast-ultrasonography through different views in healthy dogs*. J Vet Intern Med, **32**, 1308–18.
9. **Dillon RA, Tillson DM, Wooldridge A, et al** (2014): *Effect of pre-cardiac and adult stages of Dirofilaria immitis in pulmonary disease of cats: CBC, bronchial lavage cytology, serology, radiographs, CT images, bronchial reactivity, and histopathology*. Vet Parasitol, **206**, 24–37.
10. **Hnatusko AL, Gicking JC, Lisciandro GR** (2021): *Anaphylaxis-related hemoperitoneum in 11 dogs*. J Vet Emerg Crit Care, **31**, 80–85.
11. **Jehle D, Davis E, Evans T, et al** (1989): *Emergency department sonography by emergency physicians*. Am J Emerg Med, **7**, 605–11.
12. **Kim SY, Park KT, Yeon SC, et al** (2014): *Accuracy of sonographic diagnosis of pneumoperitoneum using the enhanced peritoneal stripe sign in beagle dogs*. J Vet Sci, **15**, 195.
13. **Kirkpatrick AW, Sirois M, Ball CG, et al** (2004): *The hand-held ultrasound examination for penetrating abdominal trauma*. Am J Surg, **187**, 660–65.
14. **Lanitis S, Zacharioudakis C, Zafeiriadou P, et al** (2012): *Incidental Findings in Trauma Patients during Focused Assessment with Sonography for Trauma*. Am Surg, **78**, 366–72.
15. **Lisciandro GR** (2011): *Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals*. J Vet Emerg Crit Care, **21**, 104–22.
16. **Lisciandro GR** (2012): *Evaluation of initial and serial combination focused assessment with sonography for trauma (CFAST) examinations of the thorax (TFAST) and abdomen (AFAST) with the application of an abdominal fluid scoring system in 49 traumatized cats.* J Vet Emerg Crit Care, **22**, 11.
17. **Lisciandro GR** (2020): *Cageside Ultrasonography in the Emergency Room and Intensive Care Unit*. Vet Clin North Am Small Anim Pract, **50**, 1445–67.
18. **Lisciandro GR, Country H, Specialists V** (2017): Abdominal FAST (AFAST ®) and Its Fluid Scoring System for Trauma , Triage , and Tracking - Parts I and II Southwest Veterinary Symposium 2017.
19. **Lisciandro GR, Fosgate G, Romero L, et al** (2015): *Abdominal FAST (AFAST) and Abdominal Fluid Scores in Adult and Juvenile Cats*. J Vet Emerg Crit Care, **25**, 7–8.
20. **Lisciandro GR, Gambino JM, Lisciandro SC** (2021): *Thirteen dogs and a cat with ultrasonographically detected gallbladder wall edema associated with cardiac disease*. J Vet Intern Med, **35**, 1342–1346.
21. **Lisciandro GR, Lagutchik MS, Mann KA, et al** (2008): *Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs*. J Vet Emerg Crit Care, **18**, 258–269.
22. **Lisciandro GR, Lagutchik MS, Mann KA, et al** (2009): *Evaluation of an abdominal fluid scoring system determined using abdominal focused assessment with sonography for trauma in 101 dogs with motor vehicle trauma.* J Vet Emerg Crit Care (San Antonio), **19**, 426–437.
23. **Lux CN, Culp WTN, Mayhew PD, et al** (2013): *Perioperative outcome in dogs with hemoperitoneum: 83 cases (2005-2010).* J Am Vet Med Assoc, **242**, 1385–91.
24. **Mandell DC, Drobatz K** (1995): *Feline Hemoperitoneum 16 Cases (1986-1993)*. J Vet Emerg Crit Care, **5**, 93–97.
25. **Matsushima K, Frankel HL** (2011): *Beyond focused assessment with sonography for trauma*. Curr Opin Crit Care, **17**, 606–12.
26. **Mattoon JS, Nyland TG** (2021): Small Animal Diagnostic Ultrasound Elsevier.
27. **McMurray J, Boysen S, Chalhoub S** (2016): *Focused assessment with sonography in non-trauma dogs and cats in the emergency and critical care setting.* J Vet Emerg Crit Care, **26**, 64-73.
28. **Milley E, Boysen S, Stillion J** (2017): *A general practitioner's guide to FAST cageside ultrasound techniques*. Companion Anim, **22**, 388–93.
29. **Muir W** (2006): *Trauma: physiology, pathophysiology, and clinical implications*. J Vet Emerg Crit Care, **16**, 253–63.
30. **Nelson NC, Drost WT, Lerche P, et al** (2010): *Noninvasive estimation of central venous pressure in anesthetized dogs by measurement of hepatic venous blood flow velocity and abdominal venous diameter*. Vet Radiol Ultrasound
31. **Neri L, Storti E, Lichtenstein D** (2007): *Toward an ultrasound curriculum for critical care medicine*. Crit Care Med. **35**, S290–304.
32. **Powles AE, Martin DJ, Wells IT, et al** (2021): *Physics of ultrasound*. Anaesth Intensive Care Med. **22**, 58–63.
33. **Quantz JE, Miles MS, Reed AL, et al** (2009): *Elevation of alanine transaminase and gallbladder wall abnormalities as biomarkers of anaphylaxis in canine hypersensitivity patients*. J Vet Emerg Crit Care, **19**, 536–44.
34. **Rachael B, Thomas G, Karen H, et al** (2019): *Haemoabdomen due to suspected anaphylaxis in four dogs.* Vet Rec Case Reports, **7**, 1-5.
35. **Rozycki GS** (1998): *Surgeon-Performed Ultrasound*. Ann Surg, **228**, 16–28.
36. **Rozycki GS, Pennington SD, Feliciano DV.** (2001): *Surgeon-Performed Ultrasound in the Critical Care Setting: Its Use as an Extension of the Physical Examination to Detect Pleural Effusion*. J Trauma Inj Infect Crit Care, **50**, 636–42.
37. **Sigrist NE, Adamik KN, Doherr MG, et al** (2011): *Evaluation of respiratory parameters at presentation as clinical indicators of the respiratory localization in dogs*

and cats with respiratory distress. J Vet Emerg Crit Care, **21**, 13–23.

38. **Simpson SA, Syring R, Otto CM** (2009): *Severe blunt trauma in dogs: 235 cases (1997-2003)*. J Vet Emerg Crit Care, **19**, 588–602.

39. **Udobi KF, Rodriguez A, Chiu WC, et al.** (2001): *Role of Ultrasonography in Penetrating Abdominal Trauma: A Prospective Clinical Study*. J Trauma Inj Infect Crit Care, **50**, 475–79.

40. **Walters AM, O'Brien MA, Selmic LE, et al.** (2018): *Evaluation of the agreement between focused assessment with sonography for trauma (AFAST/TFAST) and computed tomography in dogs and cats with recent trauma.* J Vet Emerg Crit Care (San Antonio), **28**, 429–35.