Journal of Equine Veterinary Science 104 (2021) 103672

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Clinical Technique

Pocket-Sized Ultrasound Versus Traditional Ultrasound Images in Equine Imaging: A Pictorial Essay

Lindsay J. Deacon*, Virginia B. Reef, Laurence Leduc, Cristobal Navas de Solis

University of Pennsylvania New Bolton Center, Kennett Square, PA

ARTICLE INFO

Article history:
Received 16 March 2021
Received in revised form 16 May 2021
Accepted 18 May 2021
Available online 3 June 2021

Keywords:
Horse
Ultrasound
Point-of-care
Pocket-sized
Hand-held

ABSTRACT

This pictorial essay aims to display the image quality of pocket-sized ultrasound devices and hospital-based equipment to provide clinicians visual information about the potential uses of point-of-care ultrasonography (POCUS) in equine practice. Twenty-two paired images were obtained using traditional ultrasound equipment and pocket-sized ultrasound devices from patients evaluated at veterinary teaching hospitals. Images of many common ultrasound windows and miscellaneous sonographic abnormalities were obtained using pocket-sized ultrasound equipment.

1. Introduction

Ultrasonography was first introduced into equine practice in the late 1970's, when it was primarily used for evaluation of the reproductive organs and cardiovascular system. Over time, its use has expanded to aid in the diagnosis of musculoskeletal injuries, thoracic and abdominal pathology, cardiac disease, high-risk pregnancies, and abnormalities of smaller parts such as eyes, vasculature, nerves, and the larynx. Ultrasound-guided aspirates and injections have become more widely performed as they provide continuous visualization of the procedure and more accurate needle placement [1,2]. Despite the established value of ultrasonography in equine practice, the size and cost of the current portable machines limits their availability and practical use by many general practitioners.

Pocket-sized ultrasound equipment is gaining popularity in human and veterinary medicine. It is used more frequently in the emergency setting and there are proponents of its use as a tool to extend the physical examination [3]. The size, cost, and usability of this technology not only renders it very attractive to both general practitioners and specialists, but also provides advantages unique to the equine practitioner. Ambulatory settings can involve lack of electricity, evaluation of immobile animals, and lack of manpower or technical assistance. Pocket-sized transducers work with a tablet or a smartphone to display the images, negating the need to transport a larger portable machine. Referral hospitals house critical patients that require frequent monitoring, are occasionally immobile, and possibly infectious. Point-of-care ultrasonography (POCUS) using pocket-sized equipment could be invaluable in these situations with the potential to provide quicker referrals, improved quality medicine, and more targeted treatments.

The only established POCUS protocols in equine medicine are FLASH [4] for acute colic in the adult horse and REP [5] for the high-risk pregnant mare. Information from other species suggests that many other clinical scenarios such as hemodynamic compromise, cardiorespiratory disease, lacerations, puncture wounds, or ultrasound-guided injections could be high yield targets for POCUS protocols [6,7,8]. A common question for equine practitioners is what kind of protocols and equipment are appropriate for use in POCUS. Prospective research studies will be needed to answer this question. POCUS protocols are specifically designed for use in targeted clinical situations and to answer specific clinical questions. The diagnostic accuracy depends not only on image quality, but also on other factors such as appropriate case selection and user training or skills. The goal of this study was to provide a pictorial essay of pocket-sized ultrasound devices and traditional ultrasound equipment to give practitioners preliminary visual information about the potential uses of pocket-sized devices for POCUS in equine practice.

2. Materials and Methods

A total of eight paired normal common ultrasound windows (Figs. 1-8) and fourteen paired images from horses with diagnosed sonographic abnormalities (Figs. 9-22) were obtained both with

* Corresponding author at: Lindsay J. Deacon, Littleton Equine Medical Center, Littleton, CO 80120

E-mail address: ldeacon@littletonequine.com (L.J. Deacon).

https://doi.org/10.1016/j.jevs.2021.103672

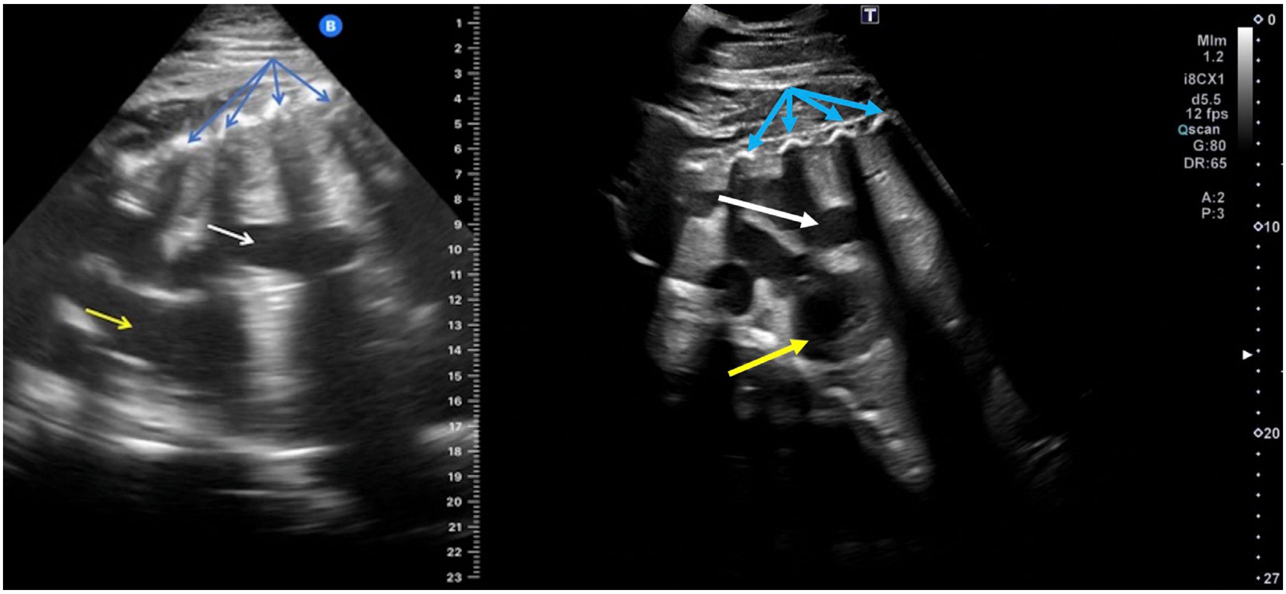

Fig. 1. Late-gestation pregnancy. Transabdominal sonogram of a 300-day gestation fetus in a 17-year-old mare obtained from the ventral abdomen (pocket-sized device[1] left and hospital based equipment[3] right). Fetal aorta (white arrow), heart (yellow arrow), and vertebral shadows (blue arrows). By placing an M-mode cursor through any portion of the fetal heart, a fetal heart rate can be obtained. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

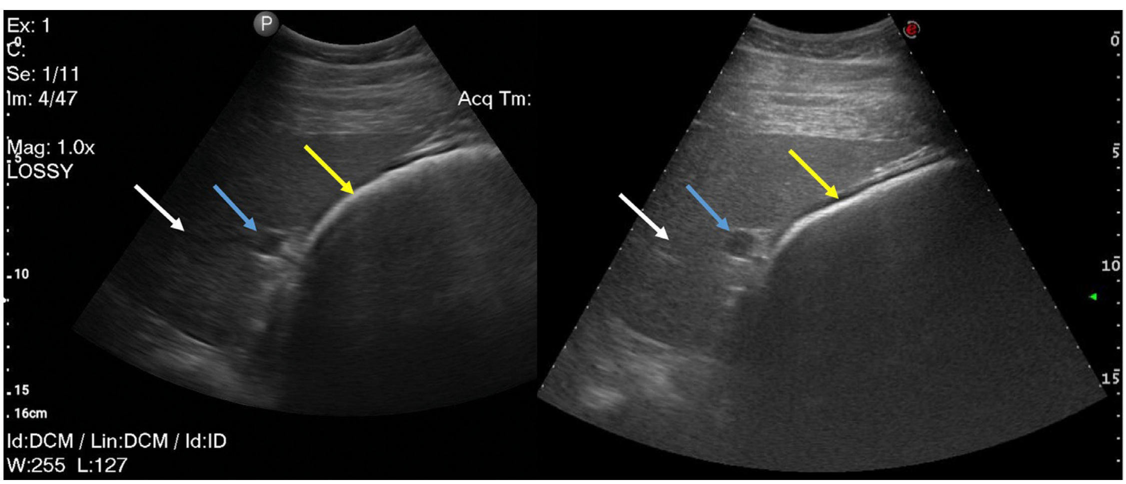

Fig. 2. Gastrosplenic window. Sonogram of a normal stomach and spleen in a 22-year-old Quarter Horse Cross gelding obtained from the left gastric window (pocket-sized device[2] left and hospital-based equipment[4] right). Stomach (yellow arrow), spleen (white arrow), splenic vein (blue arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

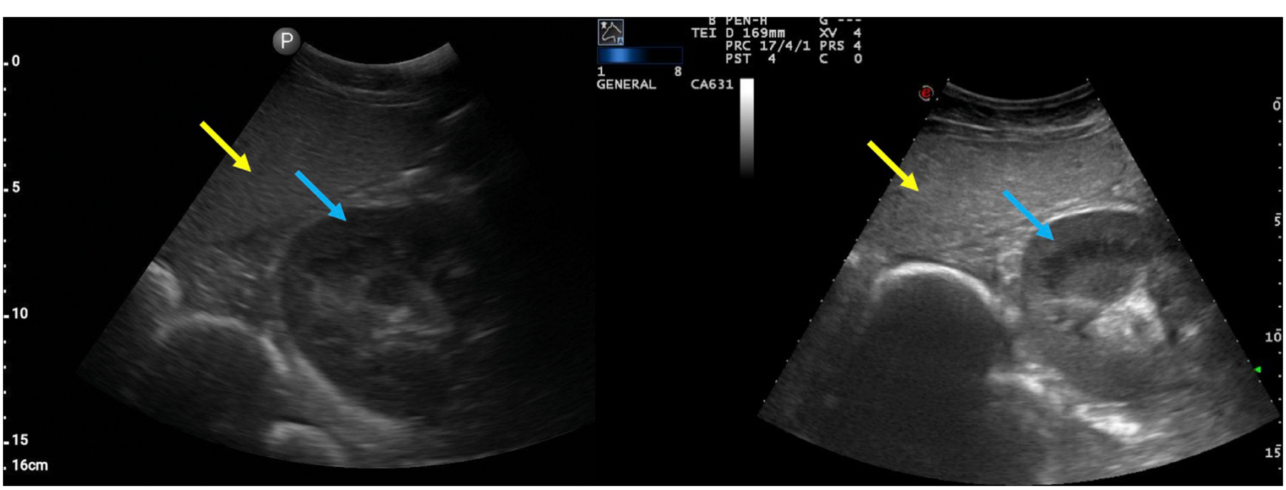

Fig. 3. Nephrosplenic window. Normal spleen and left kidney imaged in the left paralumbar fossa of a middle-aged Quarter Horse Cross gelding (pocket-sized device[2] left and hospital based equipment[4] right). Left kidney (blue arrow), spleen (yellow arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

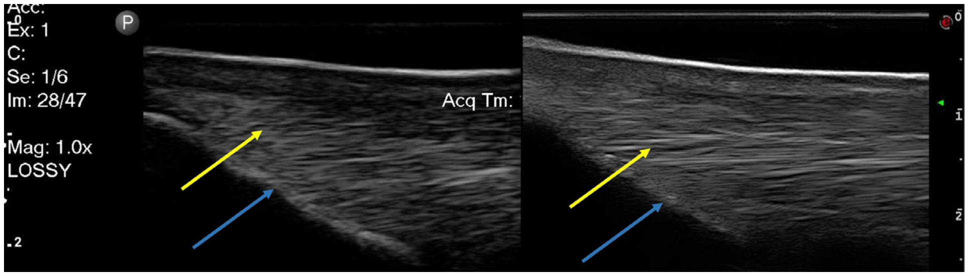

Fig. 4. Suspensory branch. Sonogram of a normal suspensory branch in a 22-year-old Quarter Horse Cross gelding (pocket-sized device[2] left and hospital based equipment[4] right). Suspensory branch (yellow arrow), abaxial surface of sesamoid bone (blue arrow). Proximal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

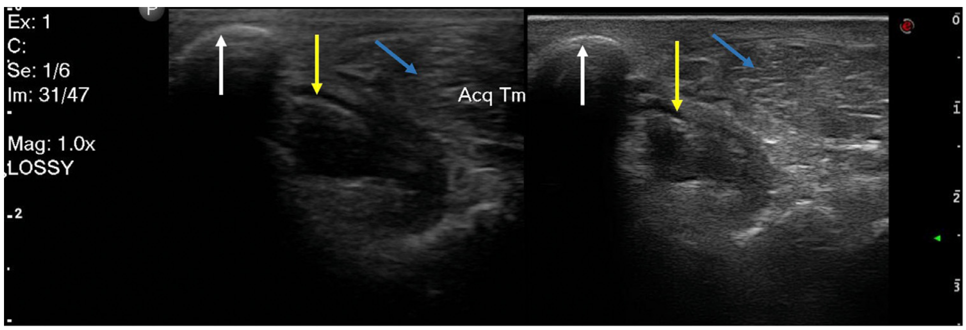

Fig. 5. Proximal suspensory ligament. Off-incidence non-weight bearing image of a normal proximal suspensory ligament in a 22-year-old Quarter Horse Cross gelding (pocket-sized device[2] left and hospital based equipment[4] right). Suspensory ligament (yellow arrow), deep digital flexor tendon (blue arrow), second metatarsal bone (white arrow). Lateral is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

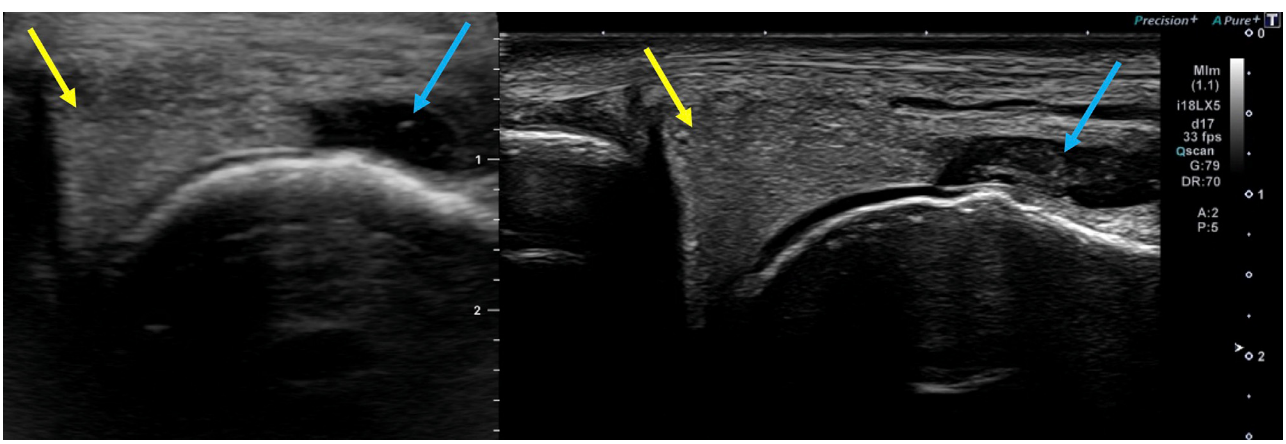

Fig. 6. Medial femorotibial joint. Sonogram of a normal medial meniscus and medial femorotibial joint in a 3-year-old Thoroughbred racehorse colt (pocket-sized device[1] left and hospital based equipment[3] right). Medial meniscus (yellow arrow), medial femorotibial joint (blue arrow). Proximal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

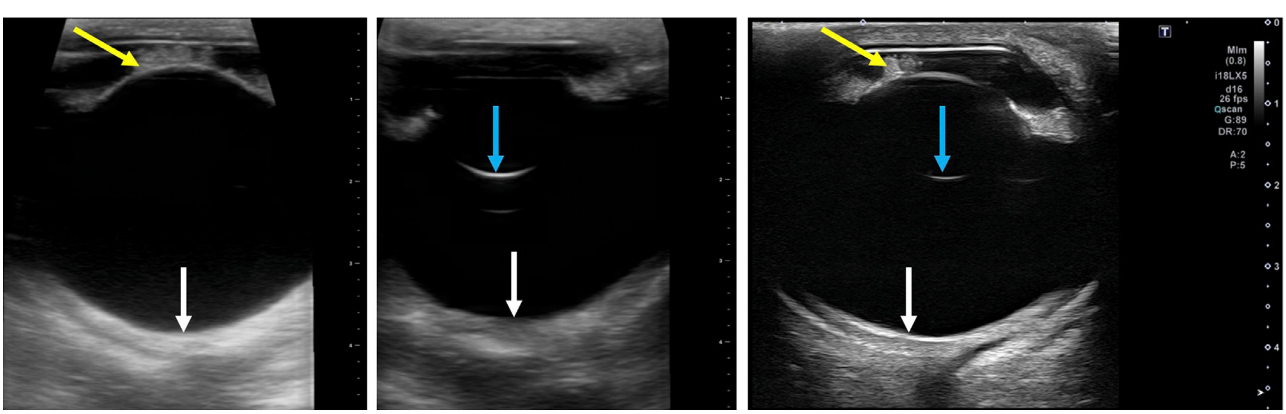

Fig. 7. Eye. Sonogram of a normal eye in a 9-year-old Standardbred gelding (pocket-sized device[1] left and middle and hospital based[3] equipment right). Posterior lens capsule (blue arrow), corpora nigra (yellow arrow), retina (white arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

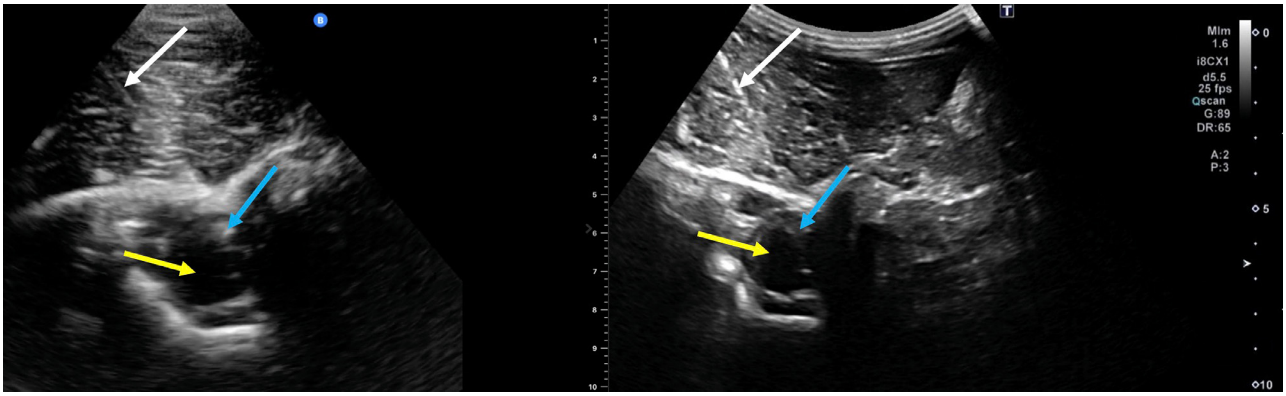

Fig. 8. C1-C2 spinal tap. Postmortem C1-C2 ultrasound-guided spinal tap in a 22-year-old Oldenburg gelding (pocket-sized device[1] left and hospital based equipment[3] right). Spinal cord (yellow arrow), subarachnoid space (blue arrow), spinal needle (white). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

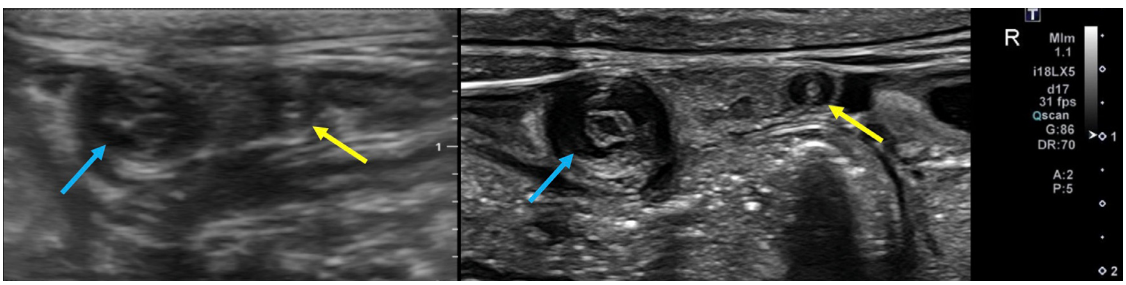

Fig. 9. Omphaloarteritis. Sonogram of the umbilical arteries and urachus of a 12-day-old Standardbred filly with mild left omphaloarteritis obtained from the ventral abdomen caudal to the external umbilical remnant (pocket-sized device[1] left and hospital based equipment[3] right). Note the thickened wall of the left umbilical artery compared to the right. The echoic tissue between the 2 arteries is the urachus at the bladder apex. Left umbilical artery (blue arrow), right umbilical artery (yellow arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

hand-held ultrasound equipment and traditional ultrasound equipment. The paired images were selected to represent a wide variation of body systems and common areas of interest for equine practitioners. The pocket-sized machines used were the Butterfly iQ[1] and Philips Lumify[2] and the traditional hospital-based ultrasound machines used were the Canon Aplio i700[3], Esaote MyLab 70[4], and Vivid E95.[5] Both standard linear-array and linear matrix-array transducers were used for musculoskeletal structures and small parts, depending on the equipment used. Similarly, low-frequency curvilinear-array and curvilinear matrix-array transducers were used for thoracic, abdominal, and late-term pregnancy sonograms. A 1.4-4.6 MHz matrix phased-array transducer was used for echocardiography. The Butterfly iQ[1] transducer is chip-based and replicates the use of the different types of traditional transducers.

The images from horses with abnormalities were obtained from cases presented to a veterinary teaching hospital that operates mainly as a specialty practice. Cases were selected if obtaining ultrasound images was clinically indicated and at the discretion of the sonographers (convenience sampling). Ultrasound-guided injections were performed on cadavers that were euthanized for reasons unrelated to this study or the area imaged. Three of the normal windows (Figs. 2, 3, and 6) were obtained from horses that were part of a teaching herd during training sessions. Horses were variably clipped for image acquisition and either 70% isopropyl alcohol or ultrasound coupling gel was used to maximize transducer contact. Trained sonographers and trainees in sonography and internal medicine obtained the images. Teaching horses were under the appropriate Institutional Animal Care and Use Committee protocol and owners of client owned animals had given permission for sonograms.

3. Results

The sonographic images collected are displayed here. Figs. 1-7 are sonographic images of normal structures. For all images dorsal, lateral, or proximal is to the right. Fig. 1 demonstrates the images from a late-gestation fetus. Pocket-sized equipment was useful in determining the non-fetal horn, fetal orientation, and fetal heart rate. M-mode echocardiograms of the fetal heart to calculate fetal heart rate, while not demonstrated here, can be performed on all equipment used in this study. Obtaining the fetal heart rate is one of the three measurements obtained in the REP of high-risk pregnant mares [5].

Figs. 2 and 3 give examples of FLASH windows, a common POCUS protocol for horses [4]. The FLASH protocol is mainly used to identify small intestinal strangulating lesions and identify colic patients that require exploratory laparotomies. A gastric window (Fig. 2) assesses the contents and degree of distention of the stomach, while the nephrosplenic window (Fig. 3) aims to identify horses with nephrosplenic entrapment or left dorsal displacement of the colon.

Figs. 4-6 demonstrate the use of POCUS in imaging normal musculoskeletal structures. All metacarpal (Fig. 4), metatarsal (Fig. 5), and stifle (Fig. 6) structures imaged using hospital-based equipment could be identified using a pocket-sized ultrasound. The

[1] Butterfly iQ, Butterfly Network Inc, 530 Old Whitfield Street, Guilford, CT 06437, USA.
[2] Lumify, Philips Healthcare, 3000 Minuteman Road, Andover, MA 01810, USA.
[3] Aplio™ i700, Canon Medical Systems USA Inc, 2441 Michelle Drive, Tustin, CA 92780.
[4] MyLab™ 70, Esaote North America Inc, 11907 Exit 5 Parkway, Fishers, IN 46037.
[5] Vivid E95, GE Healthcare, 500 West Monroe Street, Floor 21, Chicago, IL 60661.

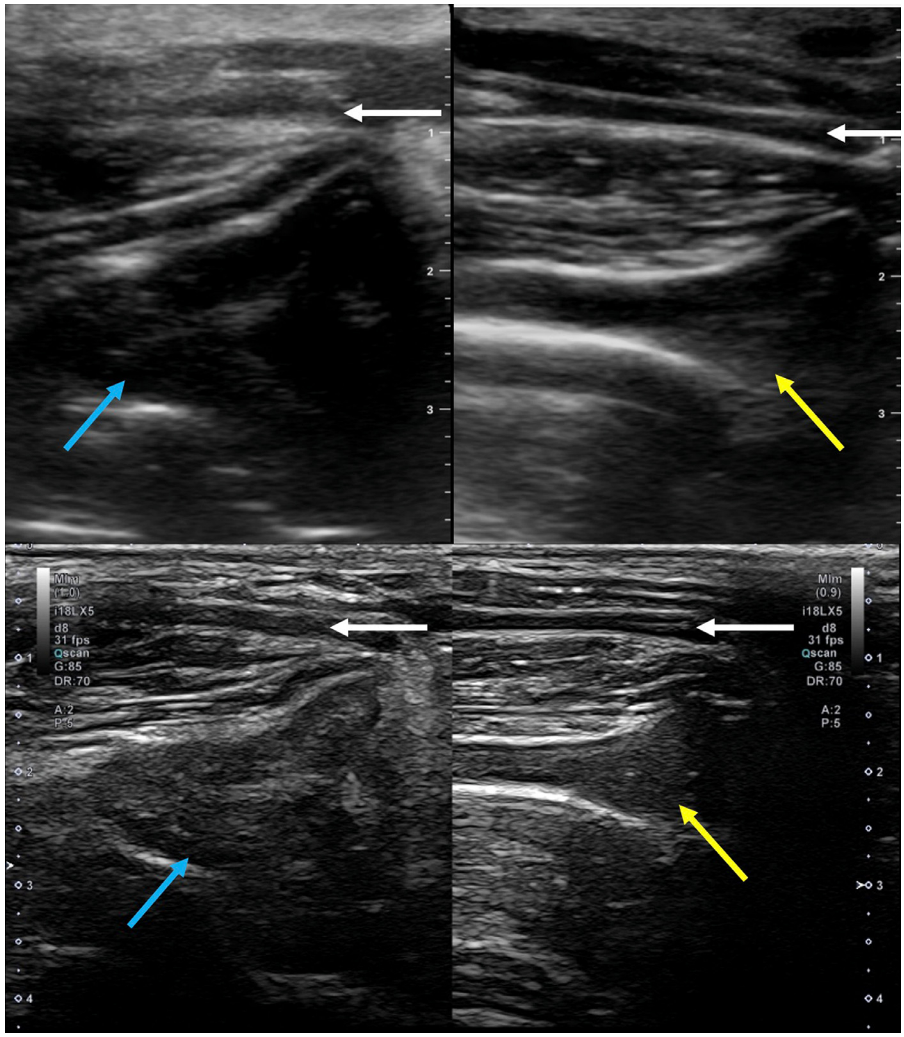

Fig. 10. Arytenoid chondritis. Sonogram of left arytenoid chondritis (left images) and a normal right arytenoid (right images) in a 13-year-old Thoroughbred mare (pocket-sized device[1] top and hospital based equipment[3] bottom). Note the enlargement of the left arytenoid cartilage and the loss of the normal 'trumpet' shape. Left arytenoid (blue arrow), right arytenoid (yellow arrow), thyroid cartilage (white arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

comparison of hospital-based versus pocket-sized ultrasound for imaging of the equine eye is shown in Fig. 7. The window needed to obtain an ultrasound-guided spinal tap at C1-C2 is demonstrated in Fig. 8. The needle is visible in the image produced by the pocket-sized device targeting the dorsal aspect of the subarachnoid space and can be used for aspirates or catheterization [9,10].

Figs. 9-22 are sonographic images of pathologies involving a variety of structures. In twelve out of fourteen cases with sonographic abnormalities, images were obtained with the pocket-sized ultrasound after a diagnosis was achieved with the hospital-based equipment and when a diagnosis or characteristic sonographic appearance had been obtained. Exceptions were Figs. 11 and 12 in which images with pocket-sized ultrasound were obtained first and prompted imaging with traditional equipment.

Fig. 9 depicts the use of pocket-sized ultrasound equipment to image internal umbilical structures [11]. Umbilical ultrasonography is used often to assess this area in the equine neonate and is potentially useful to evaluate foals with fever of unknown origin, hyperfibrinogenemia, or enlarged external umbilical remnants. Laryngeal images are displayed in Fig. 10. In this case there was severe enlargement of the left arytenoid cartilage when compared to the right, along with loss of its normal 'trumpet' shape [12]. Fig. 11 displays one of the potential uses of POCUS in an intensive care setting as a tool to support physical examination findings. Palpable thickening of the jugular vein with heat, pain, and swelling in this region, prompted this sonographic examination [13]. Ultrasonography revealed an echoic thrombus, partially occluding the left jugular vein.

Figs. 12 and 13 illustrate the potential use of pocket-sized ultrasonography in assessment of both structural and functional cardiovascular abnormalities. While a complete echocardiogram was performed on both patients using standard hospital-based equipment, the pathology was then identified using a pocket-sized ultrasound device suggesting its potential use as a screening and monitoring tool for selected indications. Fig. 12 demonstrates thickening of the aortic valve leaflets in a horse with a holodiastolic decrescendo murmur of aortic regurgitation and nodular lesions on the aortic valve cusps. The horse in Fig. 13 had a new loud systolic murmur, a slightly increased heart rate at 48 beats/minute, and a slightly increased resting respiratory rate of 20 breaths/minute. Marked left atrial and left ventricular enlargement and a pattern of left ventricular volume overload is visible in both sets of images. The enlargement of the pulmonary artery, compared to the aortic diameter, is indicative of pulmonary hypertension [14].

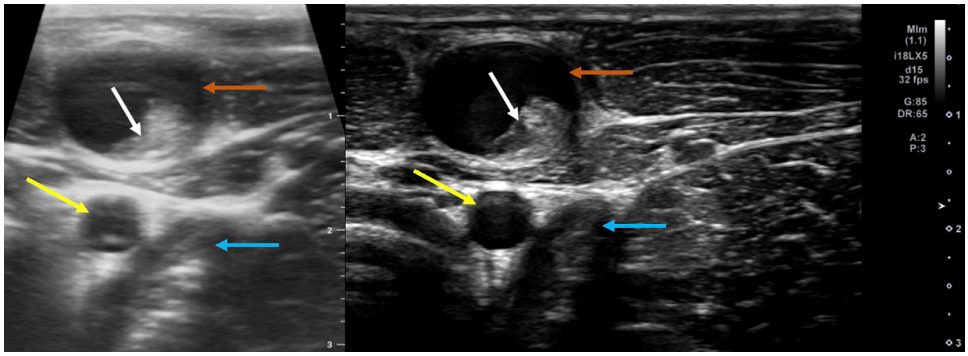

Fig. 11. Jugular vein thrombosis. Sonogram of partial jugular vein thrombosis in a 7-month-old colt (pocket-sized device[1] left and hospital based equipment[3] right). Note the echoic material within the lumen of the jugular vein, partially occluding the vein. Jugular vein (orange arrow), thrombus (white arrow), carotid artery (yellow arrow), esophagus (blue arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

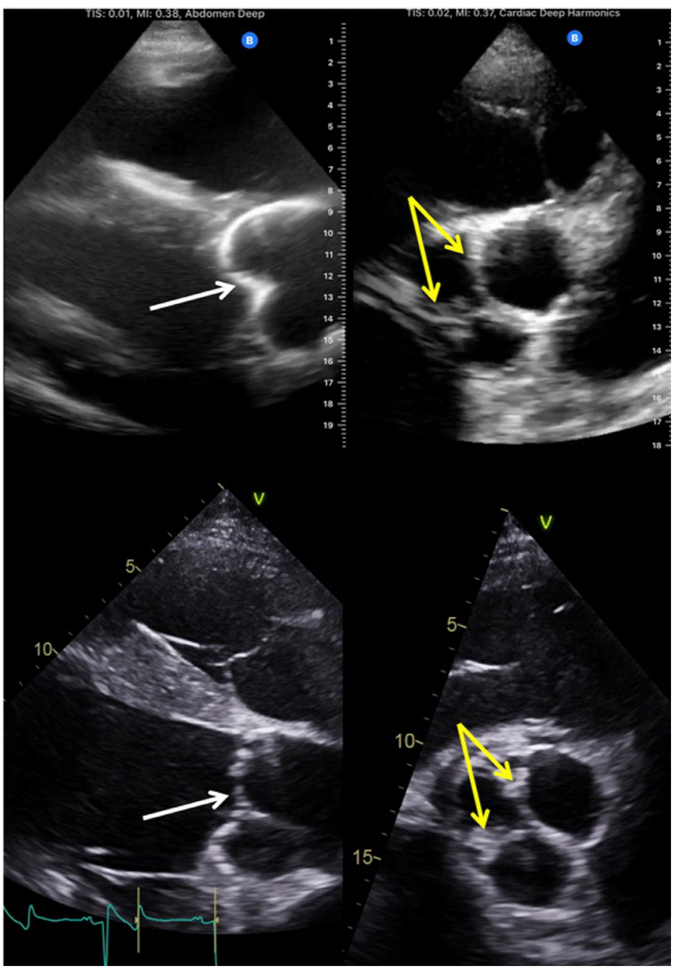

Fig. 12. Aortic valve degeneration. Echocardiogram of a 5-year-old gelding with a murmur of aortic regurgitation (pocket-sized device[1] top and hospital based equipment[5] bottom) showing diffuse thickening of the aortic valve (long axis, left, white arrow) and discrete nodular areas in the non-coronary cusp (short axis, right, yellow arrows). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Figs. 14-18 demonstrate pathology associated with a variety of abdominal organs. Cecal lymphadenopathy is visible in Fig. 14, along with marked thickening of the cecal wall and loss of the normal wall layering in a yearling with *Lawsonia intracellularis*. Fig. 15 is an example of the medullary rim sign in the right kidney of a yearling. The marked biliary distention in the horse in Fig. 16 is visible with the pocket-sized equipment, as is the biliary sludge and echoic swirling abdominal fluid consistent with hemoabdomen. Fig. 17 demonstrates abdominal masses and oval-shaped hyperechoic areas within the spleen, diagnosed as blood clots on post-mortem examination and histopathology. Separation of the chorioallantois with accumulation of echogenic fluid is visible in Fig. 18 in a mare with Nocardioform placentitis. Measuring the combined uteroplacental thickness (CTUP) here is one of the three assessments made in the REP examination in high-risk pregnant mares [5].

Fig. 19 shows the presence of a pleural abscess, fluid, and fibrin and suggests that protocols to evaluate thoracic disease that are used in other species such as TFAST (Thoracic Focused Assessment with Sonography for Trauma, Triage, and Tracking) [8] may have potential uses in equine medicine.

Figs. 20-22 depict several musculoskeletal abnormalities. Fig. 20 is an example of a typical superficial digital flexor core lesion with acute swelling of the palmar metacarpal region in the forelimb. Fig. 21 also shows the superficial digital flexor tendon but in the hind limb within the calcanean bursa. Fig. 22 shows images of two different compartments of an intramuscular abscess.

4. Discussion

This study shows that pocket-sized ultrasound equipment can obtain images of normal structures and of associated pathology from common ultrasound windows in horses presented to a veterinary teaching hospital. We displayed the images side by side to images obtained with traditional ultrasound equipment. In the authors opinion, while the images produced by pocket-sized equipment were of lesser quality, they likely would have been adequate for decision making in a point-of-care situation. It is important to highlight that ultrasonography is a very operator dependent imaging modality and the level of training of the sonographer are key to obtain and interpret images. The clinical usefulness of POCUS was not tested in this study and further studies are needed to test the training/learning methods, diagnostic ability, and POCUS influence in clinical outcomes when used in different settings and by operators with different levels of training. The finding that images obtained with pocket-sized equipment were subjectively of lesser quality than images obtained with hospital-based equipment was expected. The difference in equipment cost between pocket-sized and hospital-based ultrasound equipment is approximately 5 to 50-fold. Authors of this manuscript work in specialty referral practice and do not foresee pocket-sized ultrasound replacing hospital-based equipment in the near future. However, pocket-sized ultrasonography currently may gain an important role as a stall side diagnostic and teaching tool.

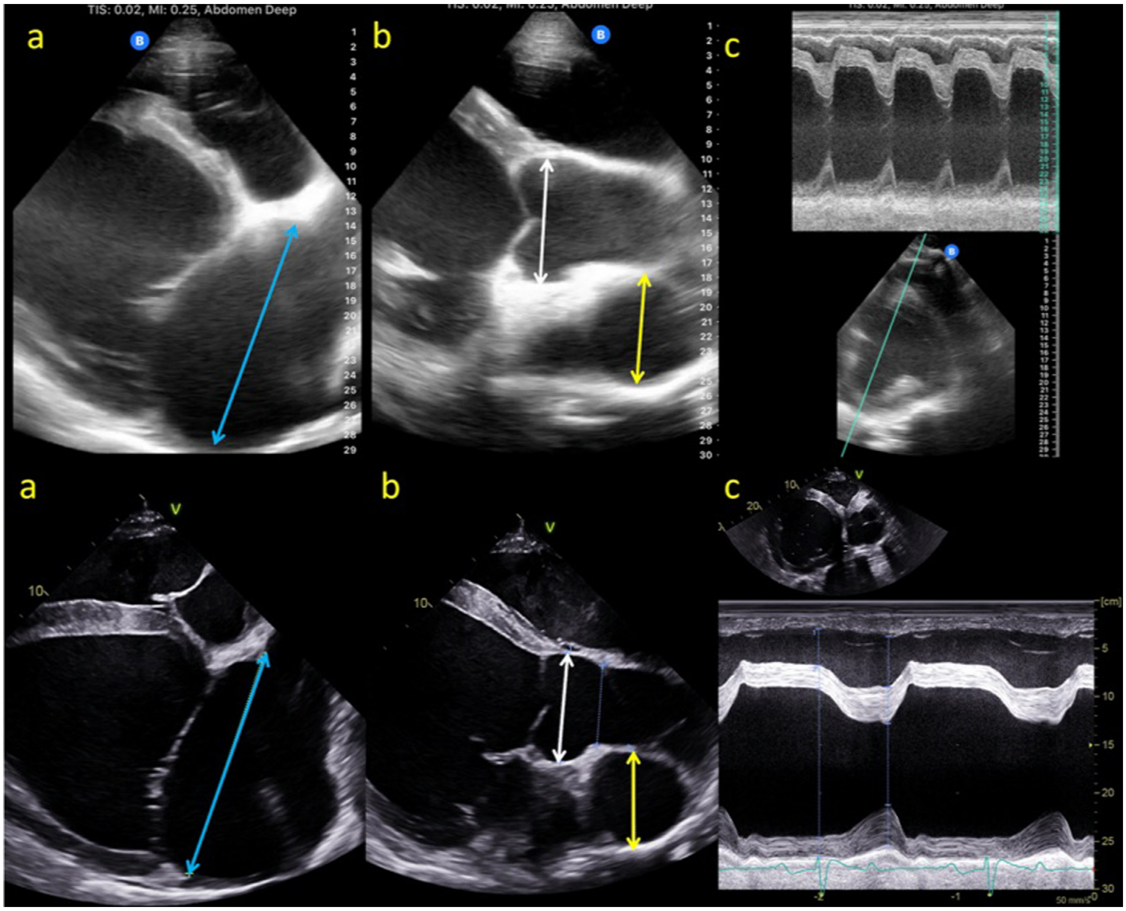

Fig. 13. Heart failure. Echocardiogram of a 15-year-old gelding with severe mitral regurgitation, pulmonary hypertension and congestive heart failure (pocket-sized device[1] top and hospital based equipment[5] bottom). a- severe left atrial enlargement (blue arrow), b- enlarged pulmonary artery (yellow arrow) relative to aorta (white arrow), c- M-mode demonstrating pattern of left ventricular volume overload. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

It is important to note that sonograms were performed, in most cases, with pocket-sized ultrasound devices after having obtained a diagnosis and the diagnostic ability of the equipment was not tested. Cases selected for comparison were chosen based on clinical needs and convenience and most lesions were not subtle. The authors could have been more likely to collect images from horses in which good quality images were anticipated. Evaluating the diagnostic accuracy of pocket-sized equipment was not the goal of the study. Scanning horses without a previous diagnosis using standardized protocols, with a wider spectrum of image quality and disease severity, and clinicians with a broad range of training would be required to formally test the diagnostic accuracy of pocket-sized equipment. Further application and utility of this technology in veterinary medicine deserves exploration. An additional limitation of the study is that images were obtained by experienced formally trained sonographers and their trainees. Independently of the equipment used, acquisition and interpretation of sonograms is highly operator dependent.

The use of pocket-sized ultrasound equipment in ambulatory equine practice has many potential advantages that were not explored in this study. In rural environments, veterinary medicine may resemble human medical care in resource-limited settings. Pocket-sized devices are currently used as a tool to provide information not previously available in these settings. Recent studies suggest that in the resource-limited setting, the sensitivity of medical examinations is improved by POCUS using pocket-sized technology [15]. The relatively low cost of pocket-sized equipment may promote the democratization of ultrasonography [16] and improve imaging skills of practitioners working in practice settings for which imaging tools were not previously financially feasible. Most pocket-sized systems have associated telemedicine applications. Being able to access guidance and advice from a remote specialist at the click of a button may open unprecedented opportunities of clinical assistance, collaboration, teaching, and learning [17].

Trends in medical education favor the use of ultrasonography beyond an imaging technique and suggest that it could be a useful tool to ‘bridge the gap between the classroom and the clinic floor’ [18]. Some trends in education have referred to pocket-sized ultrasonography as the stethoscope of the 21st century [19]. There are controversies and lack of high-level evidence to support this statement, however preliminary evidence and personal experiences make exploration of the advantages of this equipment as an educational tool a worthwhile effort.

4.1. Conclusions

We conclude that pocket-sized ultrasound equipment can be used to obtain images of structures from common windows and common sonographic abnormalities in equine practice. This technology could become useful in many clinical scenarios and has the potential of being transformative in settings like rural practice, stall-side evaluation, and teaching of veterinary students. The diagnostic accuracy of POCUS and its impact on emergency and critical care medicine as well as on veterinary medical education deserves further attention.

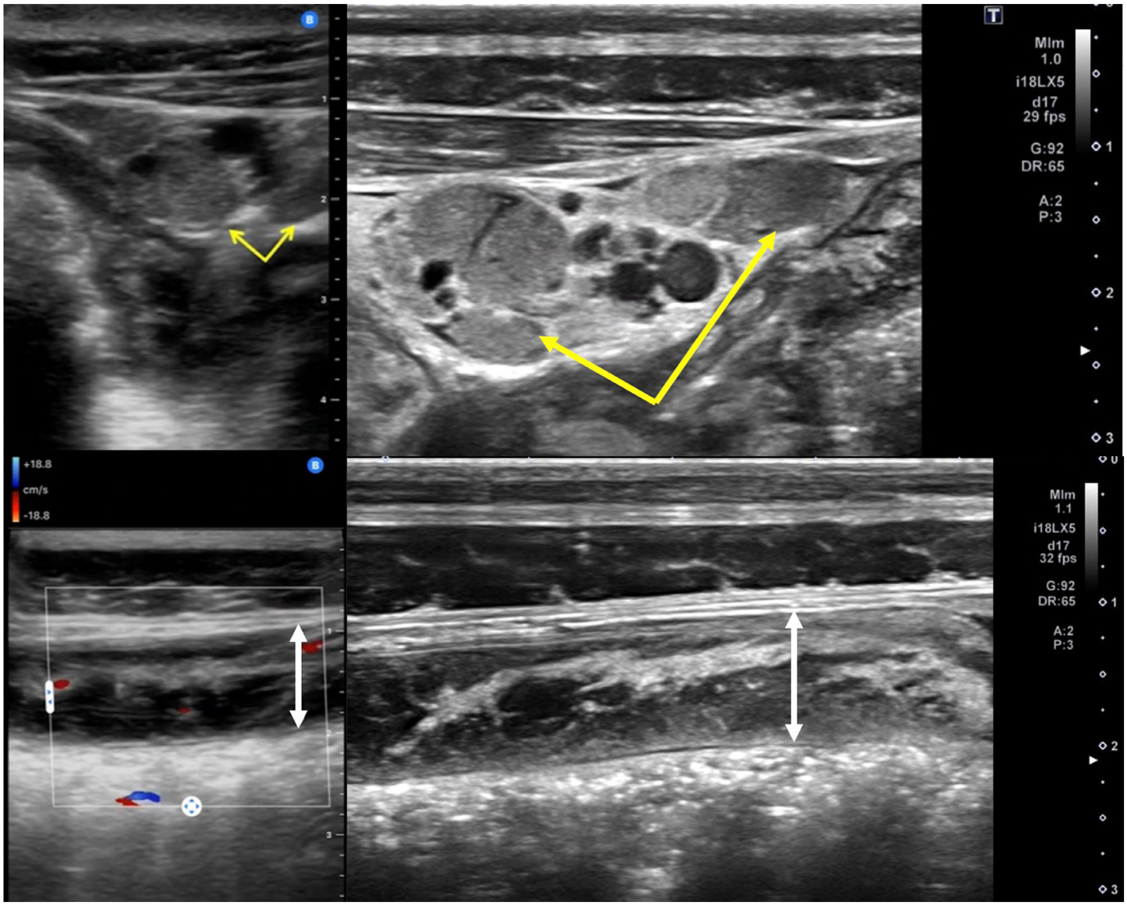

Fig. 14. Lymphadenopathy and gastrointestinal thickening. Mesenteric lymphadenopathy (top, yellow arrows) and cecal thickening (bottom, white arrow) in a 7-month-old colt with *Lawsonia intracellularis* infection (pocket-sized device[1] left and hospital based equipment[3] right). This cecal wall is approximately 10 mm thick with marked loss of the normal wall layering. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

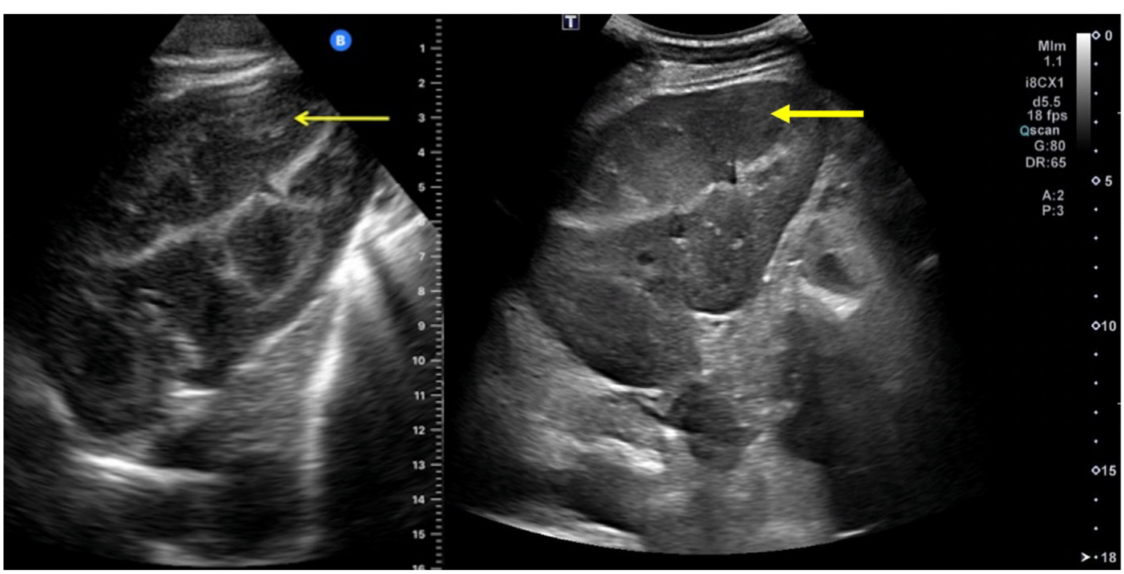

Fig. 15. Medullary rim sign. Right kidney displaying medullary rim sign (yellow arrow) in a 9-month-old Thoroughbred colt (pocket-sized device[1] left and hospital-based equipment[3] right). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

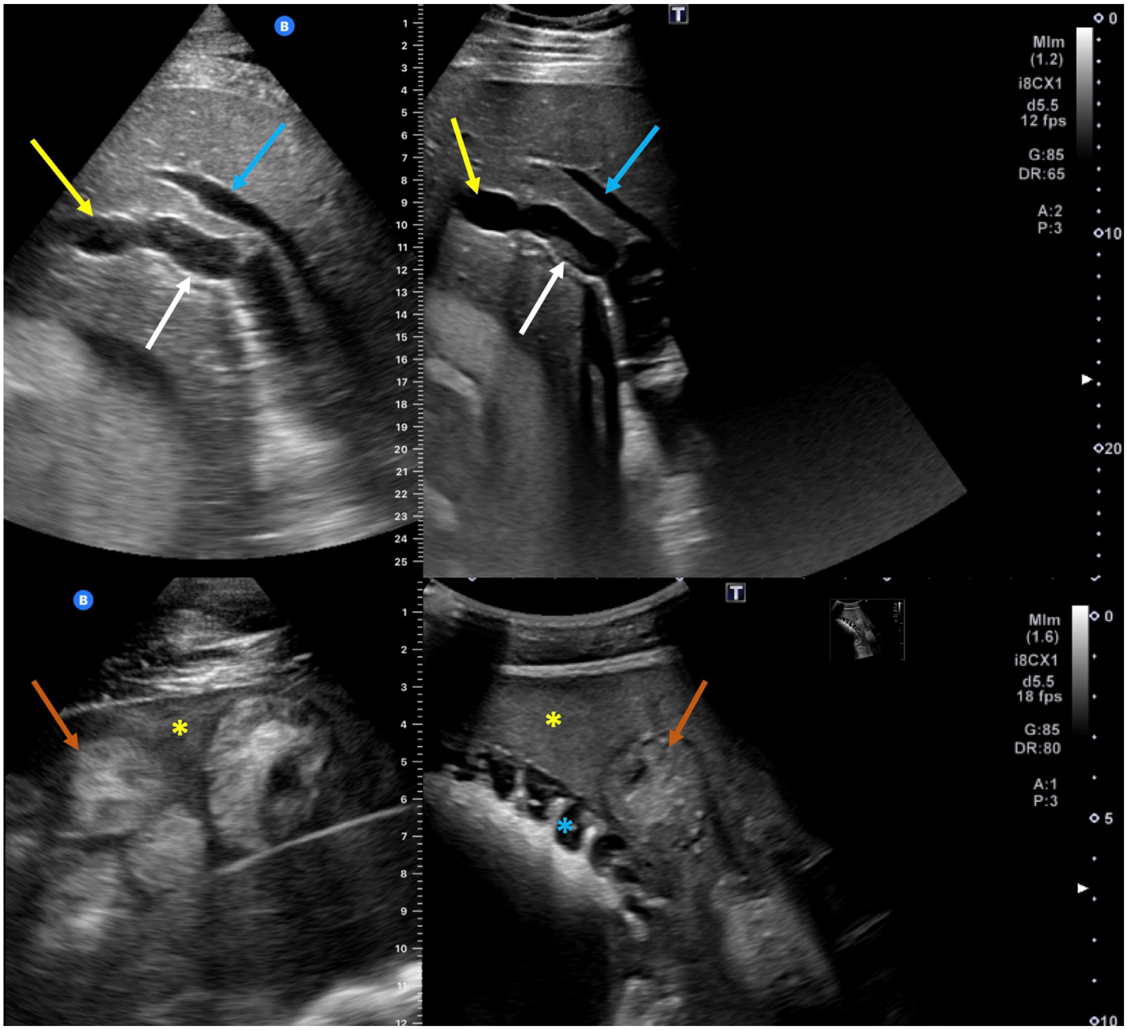

Fig. 16. Cholangiohepatitis. Cholangiohepatitis and hemoperitoneum in a 3-year-old Thoroughbred filly (pocket-sized device[1] left and hospital based equipment[3] right). A markedly distended bile duct (yellow arrow) containing biliary sludge (white arrow) is readily visible. The echogenic swirling fluid (yellow asterisk) is consistent with hemoperitoneum. Vessel (blue arrow), small intestine (orange arrow), edematous large colon (blue asterisk). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

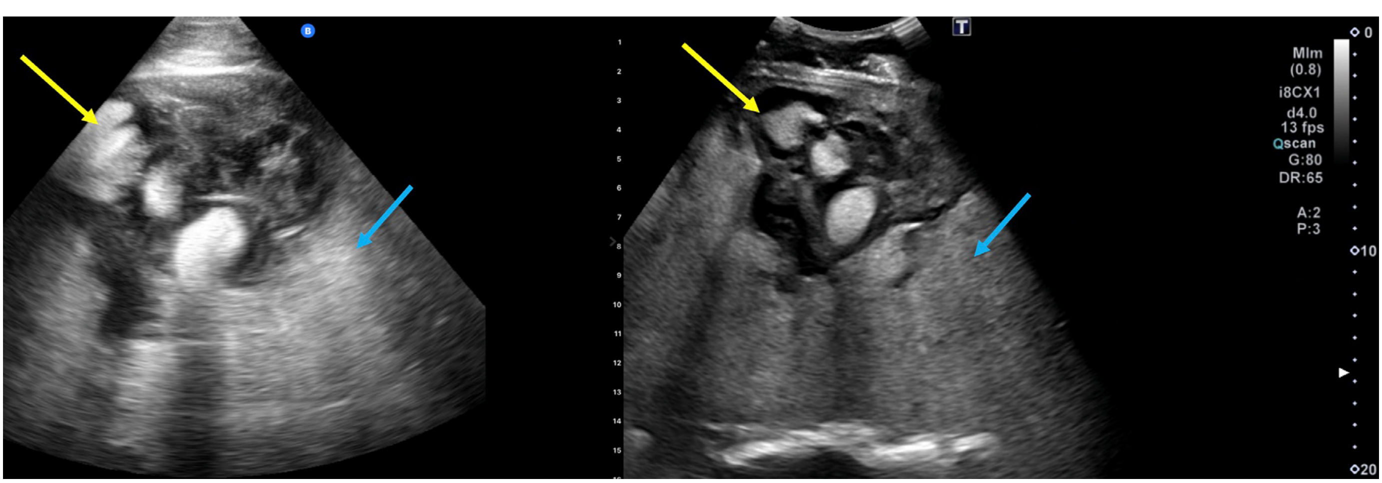

Fig. 17. Splenic hematomas. Sonogram of splenic masses in a 25-year-old Thoroughbred cross mare (pocket-sized device[1] right and hospital based equipment[3] left). Spleen (blue arrow), splenic mass (yellow arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

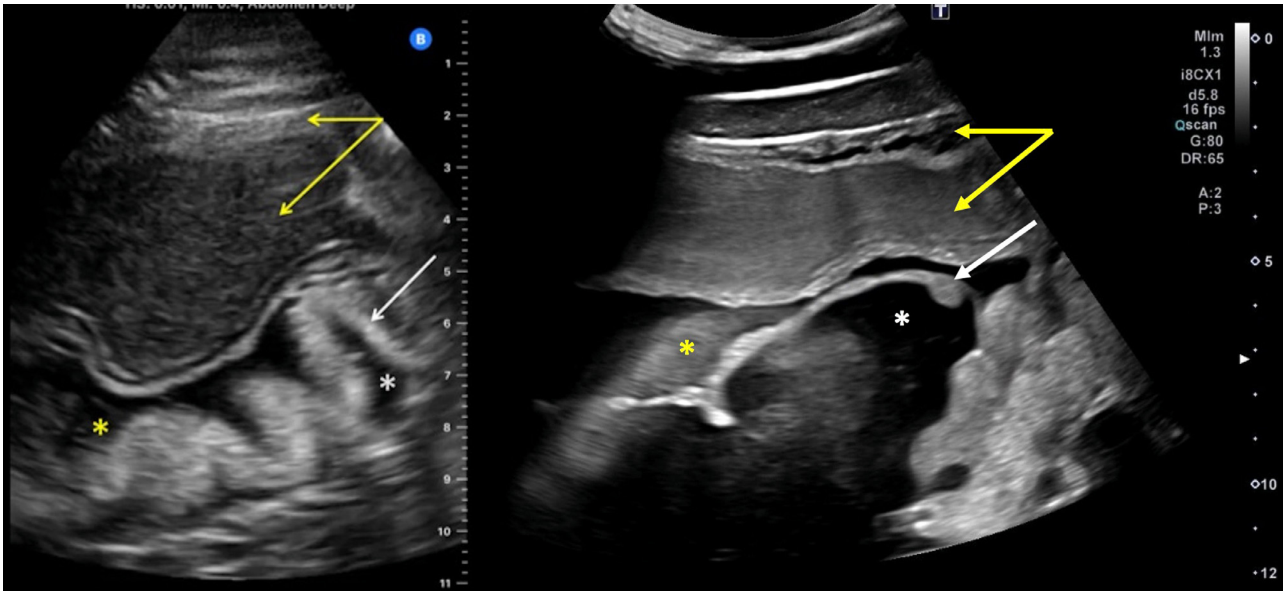

Fig. 18. Placentitis. Transabdominal sonogram of a 17-year-old mare with nocardioform placentitis (pocket-sized device[1] left and hospital based equipment[3] right). Note the marked separation between the uterus and the chorioallantois of 2-5 cm. Placental separation and copious echoic fluid (yellow arrows), amnion (white arrow), allantoic fluid (yellow asterisk), amniotic fluid (white asterisk). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

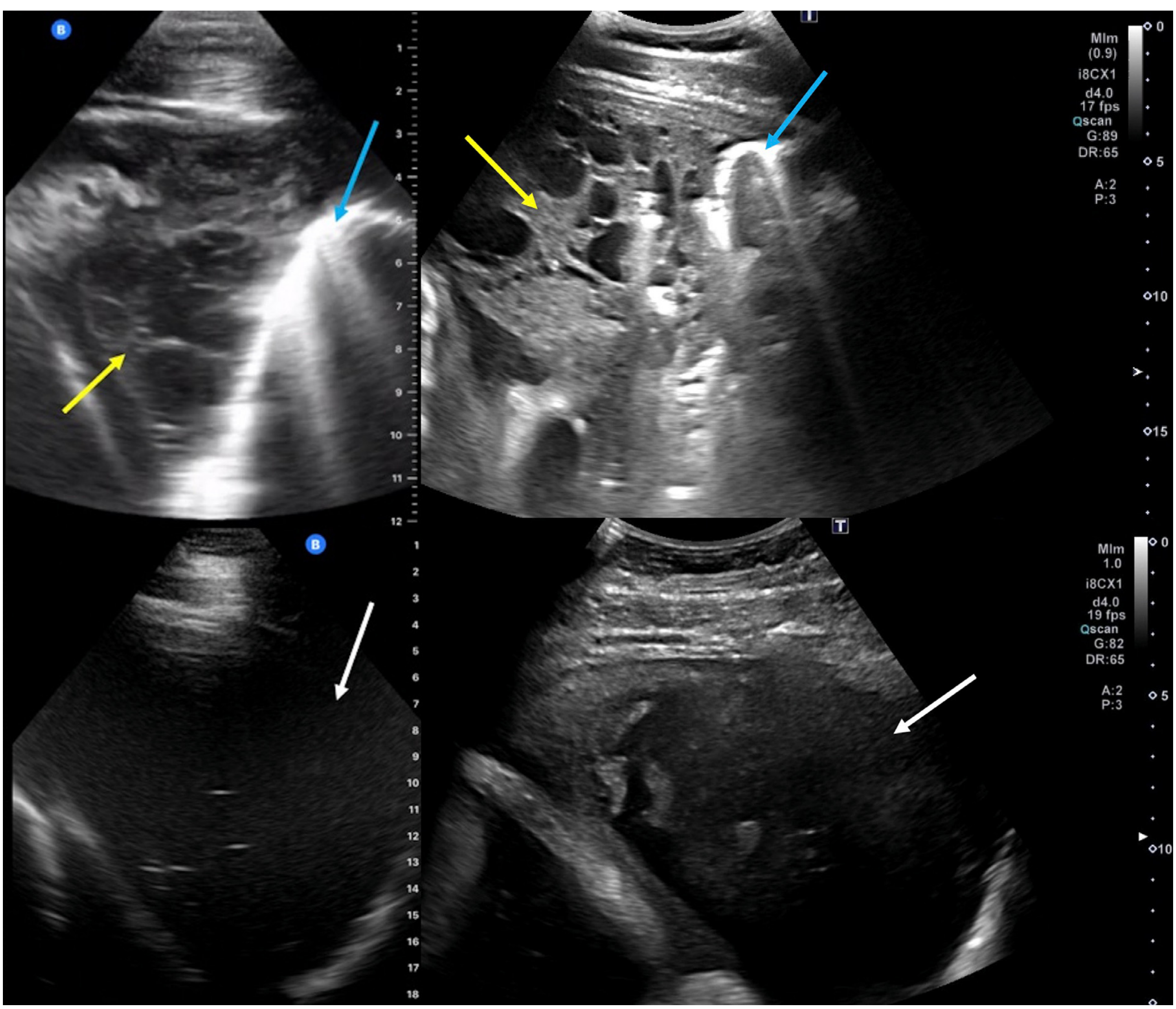

Fig. 19. Pleuropneumonia. Pleuropneumonia and pleural abscess in a 22-year-old Paint mare with a history of choke (pocket-sized device[1] left and hospital based equipment[3] right). Note the echoic capsule surrounding the pleural abscess (white arrow). Aerated cranioventral lung tip (blue arrow), fibrinous loculations within the pleural cavity (yellow arrow). Dorsal is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

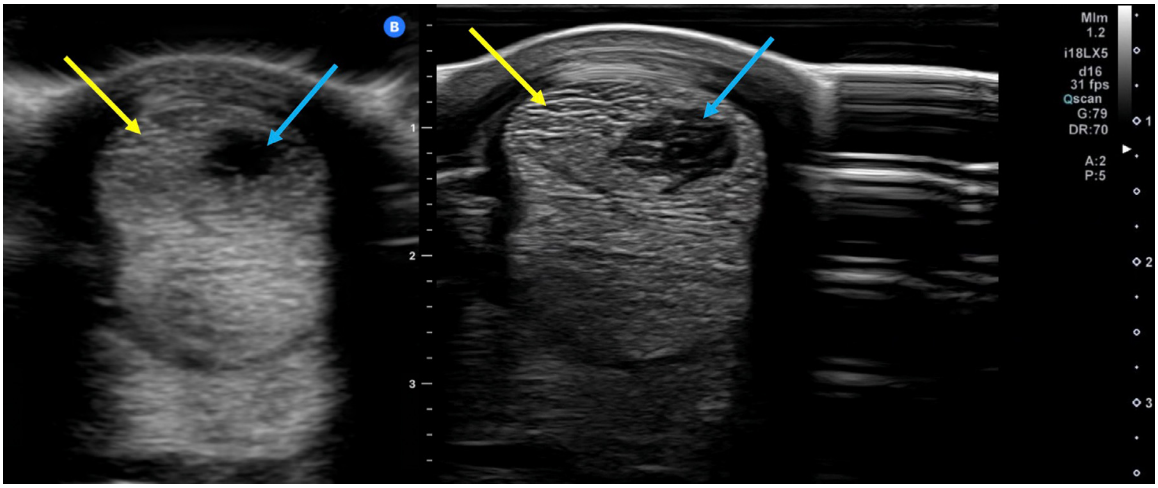

Fig. 20. Superficial digital flexor tendonitis (metacarpal region). Superficial digital flexor tendonitis characterized by a central hypoechoic lesion in a 12-year-old Irish Sport Horse gelding (pocket-sized device[1] left and hospital based equipment[3] right). Superficial digital flexor tendon (yellow arrow), hypoechoic lesion (blue arrow). Lateral is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

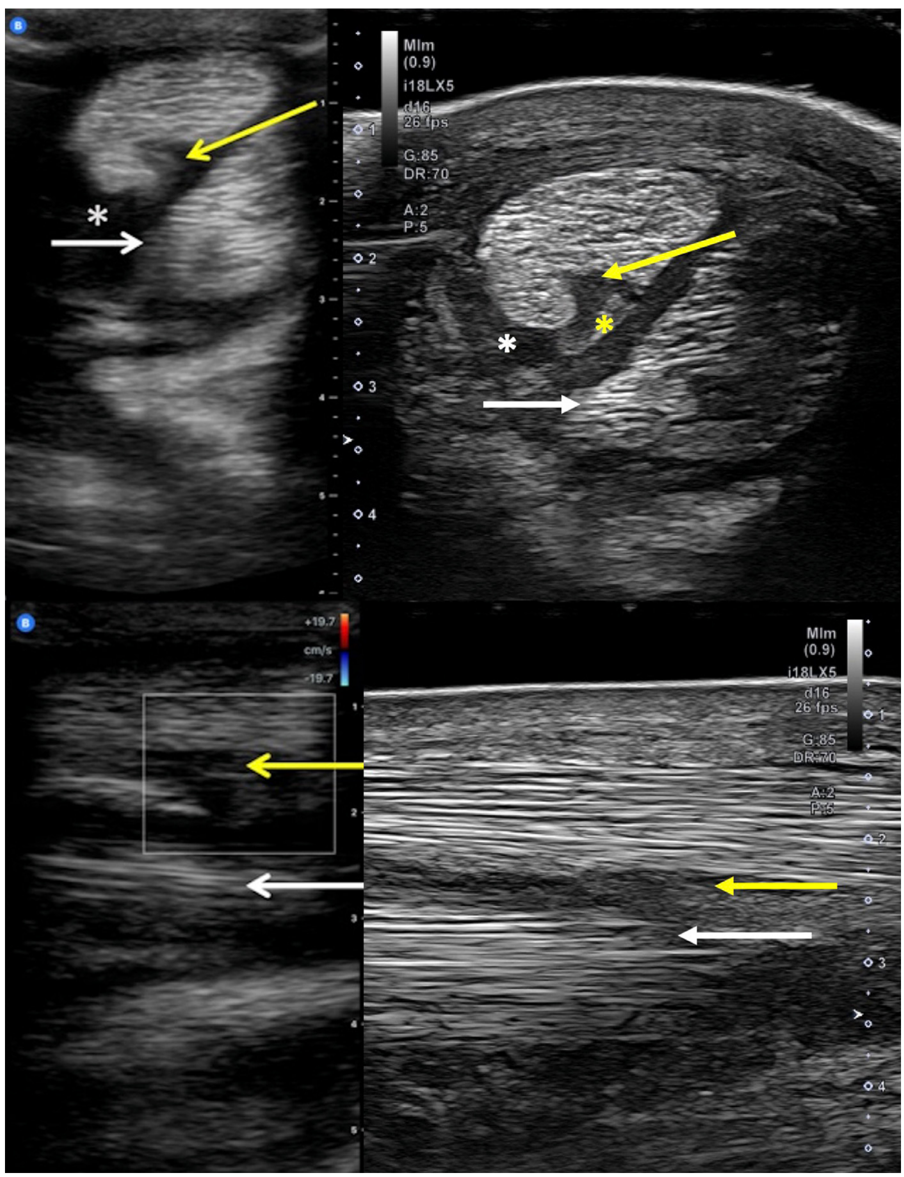

Fig. 21. Superficial digital flexor tendonitis (calcanean bursa). Superficial digital flexor septic tendonitis (yellow arrows) and calcaneal bursitis in a 11-year-old Warmblood (pocket-sized device[1] top and hospital based equipment[3] bottom). Gastrocnemius tendon (white arrows), synovial fluid (white asterisk), fibrin (yellow asterisk). Proximal or lateral is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

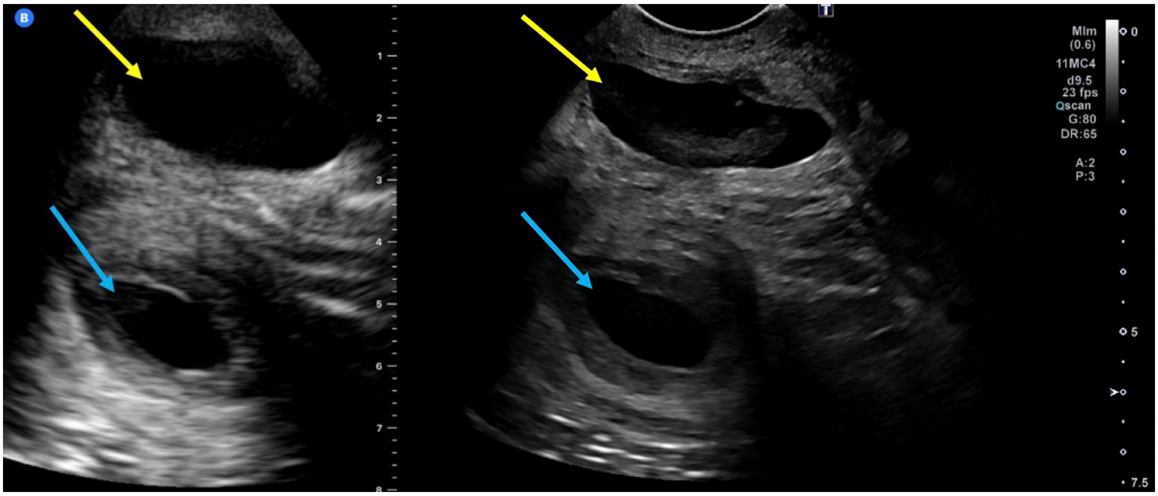

Fig. 22. Intramuscular abscess. Sonogram of an abscess within the proximal extensor carpi radialis muscle in a 7-year-old mare (pocket-sized device[1] left and hospital based equipment[3] right), characterized by superficial (yellow arrow) and deep (blue arrow) components that communicate in a different plane. Lateral is to the right. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Ethical Statement

Butterfly iQ[1] provided equipment on loan free of charge.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

The authors would like to acknowledge Butterfly iQ[1] for allowing them to use their POCUS equipment and obtain comparison images with hospital-based systems.

References

[1] David F, Rougier M, Alexander K, Morisset S. Ultrasound-guided coxofemoral arthrocentesis in horses. Equine Vet J 2007;39(1):79–83.
[2] Purefoy Johnson J, Stack JD, Rowan C, Handel I, O'Leary JM. Ultrasound-guided approach to the cervical articular process joints in horses: a validation of the technique in cadavers. Vet Comp Orthop Traumatol 2017;30(3):165–71.
[3] Leidi A, Rouyer F, Marti C, Reny JL, Grosgurin O. Point of care ultrasonography from the emergency department to the internal medicine ward: current trends and perspectives. Intern Emerg Med 2020;15(3):395–408.
[4] Busoni V, De Busscher V, Lopez D, Verwilghen D, Cassart D. Evaluation of a protocol for fast localized abdominal sonography of horses (FLASH) admitted for colic. Vet J 2011;188:77–82.
[5] Vincze B, Baska F, Papp M, Szenci O. Introduction of a new fetal examination protocol for on-field and clinical equine practice. Theriogenology 2019;125:210–15.
[6] Lisciandro GR. Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals. J Vet Emerg Crit Care 2011;21:104–22.
[7] Atkinson P, Bowra J, Milne J, Lewis D, Lambert M, Jarman B, et al., Members of the International Federation of Emergency Medicine Sonography in Hypotension and Cardiac Arrest Working Group. International Federation for Emergency Medicine Consensus Statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point of care ultrasound for undifferentiated hypotension and during cardiac arrest. CJEM 2017;19(6):459–70.
[8] Walters AM, O'Brien MA, Selmic LE, Hartman S, McMichael M, O'Brien RT. 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 2018;28(5):429–35.
[9] Pease A, Behan A, Bohart G. Ultrasound-guided cervical centesis to obtain cerebrospinal fluid in the standing horse. Vet Radiol Ultrasound 2012;53(1):92–5.
[10] Hurcombe SD, Morris TB, VanderBroek AR, Habecker P, Wulster K, Hopster K. Cervical epidural and subarachnoid catheter placement in standing adult horses. Front Vet Sci 2020;7:232.
[11] McCoy AM, Lopp CT, Kooy S, Migliorisi AC, Austin SM, Wilkins PA. Normal regression of the internal umbilical remnant structures in Standardbred foals. Equine Vet J 2020;52(6):876–83.
[12] Garrett KS, Embertson RM, Woodie JB, Cheetham J. Ultrasound features of arytenoid chondritis in Thoroughbred horses. Equine Vet J 2013;45(5):598–603.
[13] Gardner SY, Reef VB, Spencer PA. Ultrasonographic evaluation of horses with thrombophlebitis of the jugular vein: 46 cases (1985-1988). Am Vet Med Assoc 1991;199(3):370–3.
[14] Johansson AM, Gardner SY, Atkins CE, LaFevers DH, Breuhaus BA. Cardiovascular effects of acute pulmonary obstruction in horses with recurrent airway obstruction. J Vet Intern Med 2007;21(2):302–7.
[15] Epstein D, Petersiel N, Klein E, Marcusohn E, Aviran E, Harel R, et al. Pocket–size point-of-care ultrasound in rural Uganda – a unique opportunity "to see," where no imaging facilities are available. Travel Med Infect Dis 2018;23:87–93.
[16] Dos Santos J, Borges Fernandes P, Rocha Goncalves F, Goncalves A. Moving the needle towards the democratization of echocardiography: a case report. Eur Heart J Case Rep 2019;3(4):1–5.
[17] Navas de Solis C, Bevevino K, Doering A, O'Gan D, Teller L, Underwood C. Real-time telehealth using ultrasonography is feasible in equine practice. Equine Vet Educ 2020;32:218–22.
[18] Davis JJ, Wessner CE, Potts J, Au AK, Pohl CA, Fields JM. Ultrasonography in undergraduate medical education: a systematic review. J Ultrasound Med 2018;37:2667–79.
[19] Feilchenfeld Z, Kuper A, Whitehead C. Stethoscope of the 21st century: dominant discourses of ultrasound in medical education. Med Educ 2018;52:1271–87.