ULTRASONOGRAPHIC APPEARANCE OF THE INTRAVASCULAR TRANSIT OF AGITATED SALINE IN NORMAL DOGS FOLLOWING ULTRASOUND GUIDED PERCUTANEOUS SPLENIC INJECTION

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Portosystemic shunts (PSSs) allow portal blood to bypass the liver and enter the systemic circulation. Definitive diagnosis requires surgical identification, positive contrast portography, ultrasonography, or scintigraphy. This study was designed as a preliminary step to developing an alternative/adjuvant protocol to these imaging modalities. The main goals were to establish a technique for ultrasound-guided percutaneous trans-splenic injection of agitated saline, to evaluate the feasibility of performing the test to explore the postsplenic portal vasculature highlighted by the microbubbles, and to ascertain whether agitated saline microbubbles cross the sinusoidal barrier. Agitated saline was injected into the spleen of 20 healthy sedated dogs under sonographic guidance. The transducer was then repositioned to visualize the portal vein, the caudal vena cava, and the right atrium through different acoustic windows. Satisfactory results were achieved in all dogs. The microbubbles were visualized in all dogs as small intense echo signals within the portal vein at the level of the porta hepatis immediately after injection. In 18 out of 20 dogs, the echogenic signal of the microbubbles disappeared immediately once within the hepatic parenchyma, whereas in two dogs, the echoes from the microbubbles lasted for several seconds within the intrahepatic portal vasculature. The absence of microbubbles beyond the sinusoidal barrier in all of the healthy dogs included in this study makes trans-splenic injection of agitated saline a candidate as an adjuvant technique for the diagnosis of PSS, being easy to perform and repeat, as well as safe and technically feasible. © 2010 *Veterinary Radiology & Ultrasound, Vol. 51, No. 5, 2010, pp 523–526.*

Key words: agitated saline, dog, portosystemic shunt, spleen, ultrasound.

Introduction

Congenital extrahepatic and intrahepatic macrovascular portosystemic shunts (PSSs) affect dogs and cats and their various morphologies have been described.[1–5] Portosystemic shunting allows portal blood to bypass the liver and enter the systemic circulation. Detection and morphologic characterization of PSSs through diagnostic imaging influences treatment decisions and helps to identify the shunting vessel during surgery.[5,6]

The presumptive diagnosis of a PSS is usually based on a combination of signalment and history, physical findings, and clinicopathologic abnormalities.[7] Definitive diagnosis requires surgical identification, positive contrast portography, ultrasonography, or scintigraphy.[7]

Agitated saline has been used in echocardiography to delineate cardiac divisions and in detecting right-to-left and left-to-right shunting defects. In addition, it increases the strength of Doppler signals,[8] and establishes the pattern and timing of blood flow through the heart. Agitated saline microbubbles, because of their size and instability, are unable to cross the pulmonary capillary bed, remaining in to the right heart and pulmonary arteries.[8] Thus, the presence of microbubbles in the left side is unequivocally linked to a right-to-left shunt. Based on similar principles, agitated saline may have a role in the diagnosis of PSSs.

This study was designed as a preliminary step to developing an alternative/adjuvant protocol to scintigraphic and noncontrast-aided ultrasonographic diagnosis of PSSs. The main goals were to establish a technique for ultrasound-guided percutaneous trans-splenic injection of agitated saline, to evaluate the feasibility of performing the test to explore the postsplenic portal vasculature highlighted by the microbubbles, and to ascertain whether agitated saline microbubbles are able to cross the sinusoidal barrier.

Materials and Methods

Twenty dogs with a mean age of 4.6 years (range 2–7) and a mean weight of 14.3 kg (range 7–21 kg) were studied.

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The dogs were clinically normal, based on physical and laboratory findings, abdominal radiographs, and abdominal ultrasound. The dogs were housed in the Animal Experimental Service of the University of Zaragoza.

All dogs underwent trans-splenic injection of agitated saline according to the following protocol. The dogs were sedated with intramuscular acetylpromazine and butorphanol and positioned in right recumbency. A wide range microconvex transducer (5–8 MHz) of a General Electric Logic Book XP* was used to locate the spleen. Six milliliters of 0.9% saline were agitated back and forth between two syringes connected at right angles by a three-way stopcock. A 22 G, 1.5 in. long needle, attached to the three-way stopcock via a flexible extension tube (Fig. 1), was placed in the splenic parenchyma under ultrasound guidance (Fig. 2). Maintaining the needle in the splenic pulp, the transducer was then repositioned to visualize the portal vein, the caudal vena cava, and the right atrium through three different acoustic windows.

The first acoustic window had the transducer positioned just caudal to the xiphoid. Through this window, using a sagittal plane, longitudinal images of the portal vein at the level of the porta hepatis were obtained. Maintaining the transducer caudal to the xiphoid, transverse planes were obtained to evaluate the caudal vena cava and the hepatic veins.

The second acoustic window was used to evaluate the right and dorsal aspect of the abdomen. With the patient still in right recumbency the transducer was positioned under the right side of the patient, behind the last rib, and with a slight cranial orientation. A cutout window of the ultrasound table or a sliding technique where the transducer runs between the table and the right side of the patient were used for this purpose. Longitudinal images of the caudal vena cava from the level of the right kidney cranially were obtained from this second acoustic window.

The third acoustic window was a standard echocardiographic right parasternal long axis view. Longitudinal images of the right atrium were obtained and reviewed in the near field.

At this point the total volume of agitated saline was injected, divided in three boluses of 2 ml. Each bolus was injected in >3 s. A 15 s cineloop was then recorded in each acoustic window after the injection of each single bolus. The injection site, as well as the portal vein and the caudal vena cava, were then monitored ultrasonographically for roughly 5 min after the end of the last bolus. The presence of complications, if any, was recorded.

Initially, trials were performed to determine whether injecting the agitated saline into the splenic pulp or directly into the splenic vein had an effect on the visualization of the increased intravascular echoes. In addition, two ultrasound machines were used in these initial stages: the first was used to monitor the injection site, whereas the second was used to evaluate the portal vein and caudal vena cava at the level of the porta hepatis. However, after reviewing initial results, the technique was modified to the protocol described above as no differences in the visualization of the agitated saline were detected if the injection was targeting a splenic vein or the splenic pulp and after finding no complications.

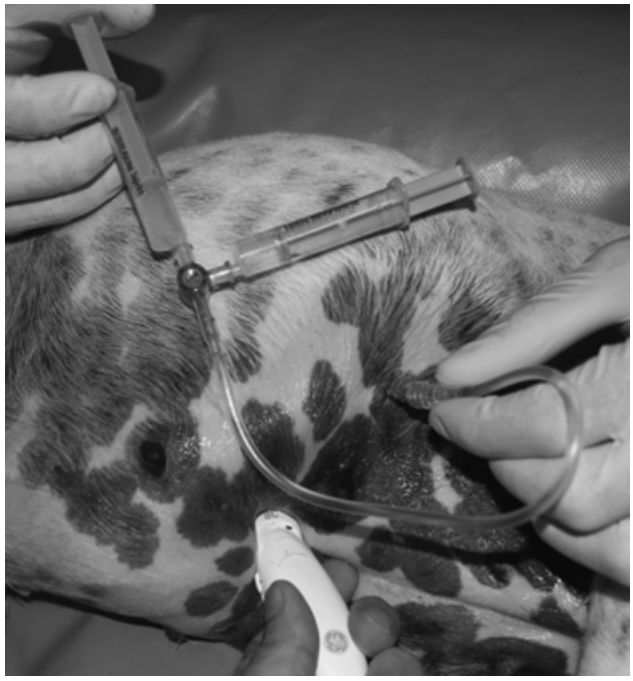

FIG. 1. A 22 G, 1.5-in.-long needle, attached to the three-way stopcock via a flexible extension tube, was placed in the splenic parenchyma.

Results

Satisfactory results were achieved in all dogs. No peritoneal extravasations or side effects were detected. The

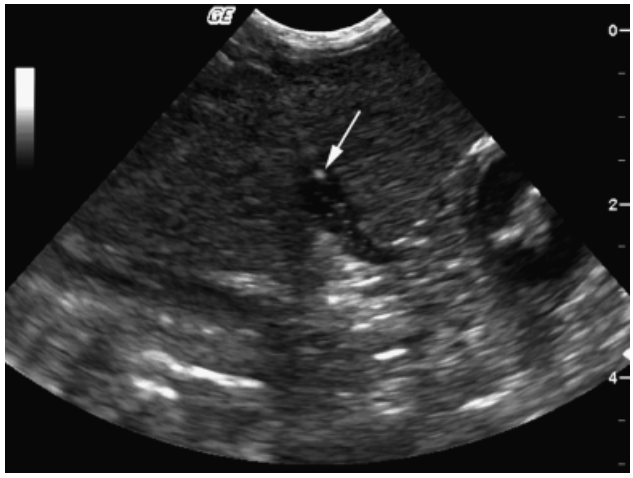

FIG. 2. Splenic vein containing microbubbles. The tip of the needle can be seen in the splenic parenchyma (arrow).

*General Electric, Fairfield, CT.

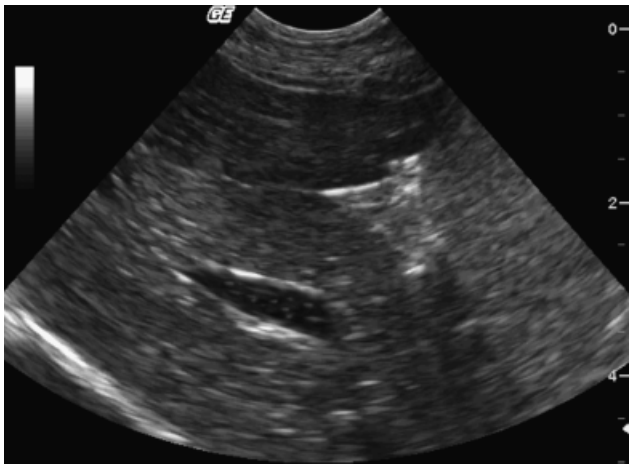

FIG. 3. Longitudinal view of an intrahepatic branch of the portal vein, obtained through a subcostal acoustic window with the transducer placed immediately caudal to the xyhoid. Microbubbles can be seen as intense intravascular echo signals within the portal vein.

microbubbles were visualized in all dogs as small, intense echo signals within the portal vein at the level of the porta hepatis immediately after the injection and for a period of <10 s (Fig. 3).

In 18 of 20 dogs, the echogenic microbubbles disappeared within the first 3 s into the hepatic parenchyma, whereas in two dogs, the echoes from the microbubbles remained trapped for 5–10 s within the intrahepatic portal vasculature.

No microbubbles were found in the caudal vena cava, the hepatic veins, or the right atrium in any of the dogs during any of the 15 s cineloops recorded.

In 16 of 20 dogs, the echopattern of the injection site returned to the preinjection state in the 5 min period following the injection. In four dogs, an anechoic area <1 cm in diameter with small internal echoes could be identified surrounding the splenic vein, disappearing in the next 15 min.

Discussion

PSSs can be a diagnostic challenge in dogs and cats.[5] Per-rectal or trans-splenic scintigraphy and ultrasonography are the most frequently used diagnostic tests for a PSS. Scintigraphy is complicated by the necessity to deal with a radiopharmaceutical and sonography is operator- and equipment dependent. Doppler techniques have been described as essential for the diagnosis of a PSS using ultrasound.[5]

Trans-splenic injection of agitated saline could overcome these limitations. The principle of using agitated saline microbubbles to follow the route of intracardiac blood flow and improve recognition of cardiac structure and anatomy[9] was applied to the trans-splenic injection of agitated saline described herein. Microbubbles can be followed through the splenic vein into the portal vein and into the intrahepatic portal vasculature in a normal dog. On the contrary, it is expected that if there is a macroscopic PSS, the microbubbles will be identified in the caudal vena cava and/or the right atrium, depending on the entry point of the shunting vessel into the systemic circulation.

The use of agitated saline is considered safe. Even when injected into a peripheral vein, complications following the injection of 3–5 ml of agitated saline are uncommon[8] in dogs. In humans, a link between bubble studies and mild cerebral ischemic events has been suggested.[10] Regarding possible complications at the injection site, it is hypothesized that the anechoic area observed in four of our dogs could be due to the different degree of vascularization of the pulp and/or the presence of hemorrhage. This anechoic area was not considered clinically relevant as the appearance of the splenic parenchyma became normal within 15 min. If peritoneal injection of the agitated saline occurs, the test can be repeated immediately.

The absence of microbubbles beyond the sinusoidal barrier makes trans-splenic injection of agitated saline a useful candidate as an adjuvant technique for the diagnosis of a PSS, being easy to perform and repeat, as well as safe and technically feasible. Although 2 ml were used in every acoustic window in this study, the size of the bolus could be adjusted according to the size of the dog, increasing to 5 ml in dogs more than 20 kg. Alas limited information regarding the path of shunting blood can be obtained with this agitated saline technique, trans-splenic injection of agitated saline should only be used to rule in/out macroscopic shunting in a relevant clinical scenario. To some extent, this technique raises the possibility of performing ultrasound guided injection of iodinated contrast medium in the splenic parenchyma to try to maximize the anatomical information obtained regarding the shunt path, if combined with radiography or fluoroscopy. However, avoiding the use of ionizing radiation is an important consideration.

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