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A multimodality imaging approach for guiding a modified endovascular coil embolization of a single intrahepatic portosystemic shunt in dogs

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ABSTRACT

Intrahepatic portosystemic shunts (IHPSS) in dogs are aberrant vascular anomalies that connect the portal and the systemic venous vessels. In most of the patients, the surgical approach is unfavourable due to the difficulties in isolating the IHPSS, making the option of a percutaneous transvenous coil embolization (PTCE) one of the safer occlusive procedures. This study describes the treatment of eight dogs with a single IHPSS using a multimodality imaging approach to guide the modified PTCE procedure. This new technique results in a decrease of 71% of the time of the entire procedure with the reduction of 91% in the time required involved the IHPSS identification and in the fluoroscopy exposure time avoiding the need for iodinated contrast agents during the procedure. Moreover, the placement of the catheter before the caval stent ensures its greater stability, enhancing the procedural safety in the phase when the coils are released and avoiding the risk of their dislocation.

1. Introduction

Intrahepatic portosystemic shunts (IHPSSs) are congenital vascular abnormalities caused by an incomplete closure of the ductus venosus, the embryonic vessel that connects the portal vein (PV) with the caudal vena cava (CVC) and ensures the blood flow from the placenta directly to the vital organs, bypassing the hepatic circulation (van Steenbeek et al., 2012). In dogs, its closure occurs 6–9 days after birth (Lamb and Burton, 2004). IHPSS is typically observed in large-breed dogs (Bostwick and Twedt, 1995) and usually presents as a single anomalous vessel within the liver. The types of IHPSS can be classified into the left divisional shunt, central divisional shunt and right divisional shunt (Lamb and White, 1998). The affected dogs may be asymptomatic or may show clinical signs of hepatic encephalopathy. Medical treatment is only palliative, whereas the traditional surgical treatment can be technically difficult.

Previous studies have described the procedure using coils and stents placed in the CVC for the treatment of congenital portosystemic shunt (CPS). (Bussadori et al., 2008; Gonzalo-Orden et al., 2000; Partington et al., 1993) However, those studies revealed several issues, such as the long fluoroscopy exposure time (Rossi et al., 2010), the use of an iodinated contrast agent, the difficulties and the length of the catheter insertion phase through the net of the auto-expandable caval stent and the high complication rate (Weisse et al., 2014).

The objective of this study was to introduce a new imaging approach for guiding a modified percutaneous trans-venous coil embolization (PTCE) in canine IHPSS, providing a reduction in both the length of time required both for the procedure and for the fluoroscopy time, avoiding a portal angiography in the absence of the complications commonly caused by coil migration.

2. Material and methods

Eight consecutive dogs with a diagnosis of IHPSS were included. Three of the dogs were referred to the Clinica Veterinaria Gran Sasso as IHPSS-affected patients, while the other five dogs received the IHPSS diagnosis at our centre based on their clinical history, blood results, and a urine analysis. The pre-operative liver function was tested in all of the IHPSS-affected dogs, included the fasting bile acids and post-prandial bile acids concentrations (Gerritzen-Bruning et al., 2006; Ruland et al., 2010). The diagnostic imaging tools were adopted to confirm the presence of IHPSS and to differentiate it from other portosystemic disorders. The liver was scanned through an intercostal approach, using two ultrasound machines operated by the same experienced sonographer (TK): an Esaote Mylab Class C (Esaote; Genova, Italy) and a Mylab 30 gold (Esaote; Genova, Italy), both of which were

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equipped with a micro convex probe CA123 (5–8 MHZ) and a linear probe LA532 (5–10 MHZ) (Esaote; Genova, Italy). To confirm the dimensions and the morphology of the shunt, each dog underwent a CT angiography examination using a GE Light Speed Plus 4 Slice CT (General Electric Healthcare, Milwaukee, WI, USA), with a dual-phase CT angiography study performed by the same experienced radiologist (SB). The protocol provided the acquisition of an abdominal survey helical scan for the orientation, a dynamic scan for timing, and finally, a tri-phase helical scan (the arterial, venal and portal phases). Iopamidol (Iopamiro®, Bracco Imaging Italia Srl; 600 mgI/Kg), the contrast agent, was introduced through a nonselective peripheral venous catheter that was positioned in the cephalic veins. Vitamin K was administered to all of the dogs (Roche SpA; Milano Italy; 0.5 mg/Kg, OS) for 3 days before the procedure, and the dogs received an infusion of plasma (12 ml/Kg) two hours before the interventional procedure (Snow et al., 2010). Thirty minutes before the plasma infusion, the dogs received chlorpheniramine maleate (6 mg/dog SC (Schering-Plough SpA, Milano, Italy). Before the procedure, a double prophylactic antibiotic therapy was administered: metronidazole (Società Prodotti Antibiotici SpA, Milano, Italy; 7.5 mg/Kg EV for 30 min) and amoxicillin–clavulanic acid (Pfizer, Latina, Italy; 20 mg/Kg SC). Each dog was anaesthetized using butorphanol (Intervet, Milan, Italy; 0.2 mg/Kg IM) approximately 15 min before the anaesthetic induction, and propofol was administered (Fresienus Kabi S.r.l. Italy; 2–4 mg/Kg EV) to induce anaesthesia. Then, the dog was intubated, and anaesthesia was maintained with an isoflurane inhalation (1–2%) (Abbott House, UK) and oxygen using an Alpha Delta volumetric ventilator (Siare Engineering International Group SRL, Crespellano, Bologna, Italy) and a semi-closed circuit with respiration. During the procedure, the dog was constantly ECG-monitored. Each dog was placed in dorsal recumbency. The ventral portion of the abdomen and the thigh region were carefully clipped of hair, scrubbed and draped to expose both of the femoral veins. The guide wires, the catheters, the stent and the coils were manipulated using standard sterile techniques. The intra-procedural multimodality imaging approach (MIA) began with the location of the IHPSS's exit using transesophageal ultrasonography (TEU) with a 022 probe (Esaote, Genova Italy). The CT images acquired before the procedure were the reference points for orientating the TEU and visualizing the IHPSS. Based on the CT images, the ultrasound beam was directed clockwise until the IHPSS and its ampulla were bidimensionally imaged. A Doppler analysis was performed to define and confirm the junction shunt flow, placing the sample volume at the connection of the shunt-draining hepatic vein. The combination of a colour Doppler (Fig. 1) and a spectral Doppler (Fig. 2) study was used to define the type and direction of the blood flow, allowing its qualitative analysis before the attenuation. Using this approach, the measurement of the CVC diameter at its IHPSS junction was obtained. Both diameters were then compared with the CT measurements to correctly estimate the dimension and the length of the auto-expandable caval stent. A small skin incision on each thigh of 5 mm facilitated the placement of the vascular introducer. The Seldinger technique was used for the vascular access. In seven of the dogs, two introducers (5–14 Fr) (Cordis Corporation, USA) were positioned in each of the femoral veins: the smaller one for the Simmons catheter (Cordis Corporation, USA) or the Cobra shaped catheter (Cordis Corporation, USA) positioning and, the other was used to release the caval auto-expandable stent. In one dog, after careful evaluation of the diameter of the femoral vein, we were successful in using only one femoral venous access, placing a 13 Fr introducer into which both the Simmons catheter and the release stent system were inserted. In all of the other dogs, a 0.035″ × 150 cm guide wire (Kimal, UK) was positioned through the introducer on the right side and a Simmons catheter or, alternatively, a Cobra-shaped catheter (Cordis Corporation, USA) was advanced percutaneously on that guide until its tip faced into the shunt. The Simmons catheter was selected when the angle between the CVC and IHPSS was less than 90°, while the Cobra-shaped catheter was used when this angle was greater than 90°. Both fluoroscopy and TEU were used to monitor the proper location of the catheter's tip (Fig. 3).

A bubble study confirmed the hook and the introduction of the Simmons or Cobra-shaped catheter inside the shunt. Five millilitres of saline mixed with five millilitres of colloid was agitated back and forth between two syringes connected by a three-way stopcock and then rapidly injected by one of the two syringes directly into the venous catheter. The correct location at the level of the shunt's junction allowed us to clearly confirm the bubble contrast's transit through the anomalous vessel into the caudal vena cava (Fig. 4). The placement of the Simmons

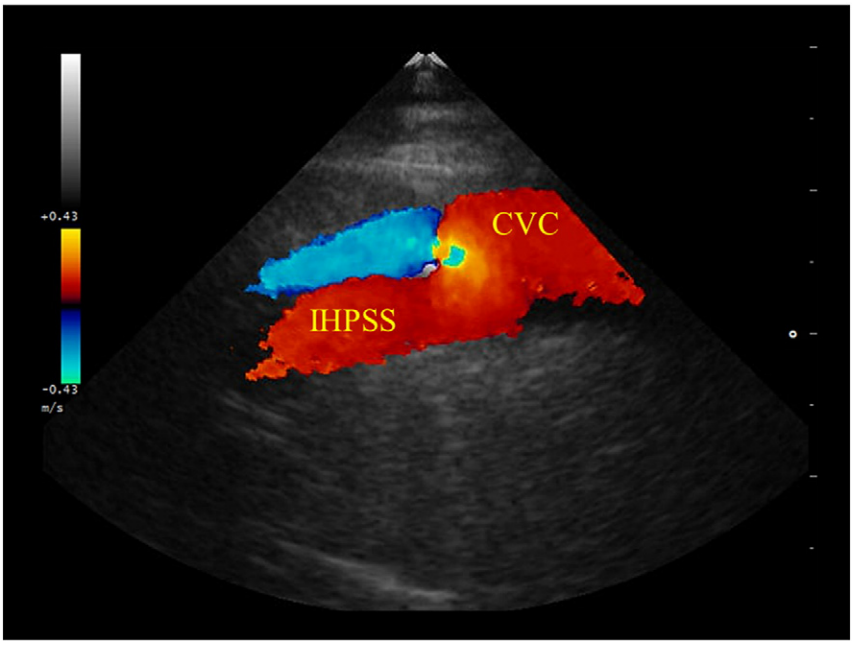

Fig. 1. Transesophageal ultrasonography colour Doppler image: a longitudinal view of the IHPSS's exit. The pre-procedural qualitative analysis of the blood flow from the left tubular type of IHPSS into the caudal vena cava. CVC: caudal vena cava; IHPSS: intrahepatic portosystemic shunt.