Intraoperative contrast echocardiography to verify the surgical occlusion of a single extrahepatic portosystemic shunt in a dog

V. Saponaro *, L. Lacitignola, F. Staffieri, A. Crovace

Department of Emergency and Organs Transplantations, Division of Veterinary Surgery, Faculty of Veterinary Medicine, University of Bari, Italy

A R T I C L E   I N F O

Article history:
Received 2 October 2010
Accepted 2 July 2011

Keywords:
Agitated saline
Portosystemic shunt
Dog
Echocardiography
Surgery

A B S T R A C T

This report details a bubble echocardiographic study carried out during the surgical treatment of a congenital single extrahepatic portosystemic shunt (PSS) in a Labrador Retriever. After celiotomy, agitated saline was injected through a jejunal vein and microbubbles appeared rapidly in the right cardiac chambers. The test confirmed the presence of a PSS, helping the surgeon to identify the vessel concerned and to rule out a second shunt. Successively, portography confirmed what the exploratory celiotomy had revealed before with the aid of the bubble study: a single shunt was located between the portal vein and the right renal vein. It was completely ligated, as all the criteria for this solution were met. Intraoperative contrast echocardiography (ICE) was easy to perform, helpful and undemanding. It is proposed here as an intraoperative ancillary test to diagnose all PSS and to confirm successful treatment when complete shunt closure is possible.

© 2011 Elsevier Ltd. All rights reserved.

A 6-month-old male, 13.5 kg, Black Labrador Retriever, was referred for a variety of clinical signs consistent with hepatic encephalopathy. The owner prevalently reported lethargy, disorientation, head pressing, ptalism, and stunted growth. Laboratory findings substantiated the suspicion of PSS. Noticeably altered parameters included low cholesterol (94 mg/dL; reference range: 130–300 mg/dL), albumin (1.7 g/dL; reference range: 2.5–4.0 g/dL), and iron (62 μg/dL; reference range: 100–250 μg/dL), normal pre- and high post-prandial bile acids (5.3 and 117 μmol/L; reference range 0–10 and 0–30 μmol/L, respectively) and high urinary bile acids (535.2 mmol/L; reference range 0–10 and 0–30 mmol/L, respectively); urea nitrogen was normal but near to the lowest range (17 mg/dL; reference range: 10–45 mg/dL). The dog also showed mild hypochromic microcytic anemia (RBC: 5.0 × 10¹²/μL, reference range 5.6–8.5 × 10¹²/μL; Hct: 28.3%, reference range: 37.1–55.8%; Hb: 8.6 g/dL, reference range: 13.1–18.7 g/dL; MCV: 56.6 fl, reference range: 59.2–73.5 fl). Blood count gradually recovered after the owner started the treatment course, although a direct visualization of the vessel’s origin was not achieved. Thus a congenital extrahepatic PSS was suspected. Having obtained the owner’s consent, surgical intervention was then planned, with three main objectives: firstly, to evaluate the usefulness of an intraoperative contrast echocardiography (ICE) following injection of agitated saline into a portal tributary, in order to demonstrate the presence of PSS; secondly, to identify the location of the shunt in order to attenuate or completely ligate it; and thirdly, to perform intraoperative portography with a C-arm mobile image intensifier (Ortopedix mod. 24/881, Gilardoni) to confirm the result of this novel procedure. After premedication with methadone (Eptadone, Molteni) (0.2 mg/kg IV), anesthesia was induced with propofol (Propofet, Esteve Veterinaria) (4 mg/kg IV) and maintained with isoflurane (Isoflo, Esteve Veterinaria) vaporized in oxygen. Ampicillin (Amplisol, Gellini) (20 mg/kg IV) was administered at the beginning of the intervention. A ventral midline celiotomy allowed the exposure of a jejunal intestinal tract, and a jejunal vein was catheterized with a 20-gauge over-the-needle catheter secured with a double ligature. Via the catheter, the direct portal pressure was estimated to be around 6 mmHg by means of a comprehensive anesthetic patient monitor (SC 6002XL, Siemens). The catheter was flushed...
with heparin solution after each use. The ultrasonographer placed a 3.5 MHz phased array transducer over a left parasternal window with the subject in dorsal recumbency and the extension of upper limbs exactly as he was previously positioned for surgery, obtaining a left apical four-chamber view. Two milliliters of saline mixed with 0.5 ml of heparinized patient’s blood was agitated back and forth between two syringes connected by a three-way stopcock and rapidly injected by one of the two syringes directly into the catheter (Arndt and Oyama, 2008). After a few seconds, a good quality right cardiac chamber echo-contrast was clearly appreciated (Fig. 1B, Video). At this time, the presence of PSS was demonstrated with 100% accuracy (Gómez-Ochoa et al., 2010). Rapid exploration of the abdomen, leaving the catheter in situ, allowed the surgeon to detect an anomalous bridging vessel between the portal vein and the right renal vein. The shunt location was ascertained simply by repeating the bubble study after a provisional shunt occlusion, which this time showed the absence of echo-contrast in the right cardiac chambers (Fig. 1A). In order to ensure that the negative echo-contrast was not due to a worsening of the hemodynamic status, the occlusion was released, thus again allowing the passage of bubbles. Successively, portography was carried out in the operating suite with fluoroscopy. Injection of a bolus of 1 ml/kg of an iodine contrast agent (Iopamiro 370 – Bracco Imaging) for each portovenogram was manually performed as quickly as possible via the existing catheter, and two sequences of 10 or so seconds were acquired both in lateral and ventro-dorsal projections without moving the subject. In the first projection, a vessel was depicted between the portal vein and the vena cava, at the level of the kidneys just before the portal trunk entered the liver parenchyma (Fig. 2). In ventro-dorsal projection, the portal blood appeared to be draining via a small branch into the right renal vein. The shunt ligation strategy was that recommended by other authors (Szatmári et al., 2003): the surgeon determines on a step-by-step basis the narrowest possible diameter that does not cause signs of serious portal hypertension. Indeed the criteria for complete or partial ligation are as follows: the intestines and the pancreas must remain acyanotic, the heart rate must not increase >15%, the portal venous pressure does not exceed 18 mmHg, the jejunal arteries and veins must not differ markedly in color from each other (Szatmári et al., 2003). In the present dog, as each of these criteria was present even after complete occlusion of the shunt and with the portal pressure being around 12 mmHg, the surgeon decided for complete ligation with silk sutures at the point where the shunt vessel entered the right renal vein, the same point provisionally occluded during the bubble study. A punch biopsy was performed and later histology revealed proliferation of hepatic arterioles associated with a reduction of portal veins and hepatocytic atrophy. After surgery, the dog showed a drastic improvement in his physical condition, so that postoperative care consisting in antibiotics and lactulose, was interrupted within two months. At that time, biochemistry revealed normal liver function, so the dog returned to a normal diet without showing any clinical signs of hepatic encephalopathy for a further two months of observation after which he was lost to follow-up.

Congenital PSS is a diversely located, macroscopic communication between the enterohepatic and systemic venous circulation. Based on this evidence, the undisturbed passage of agitated saline microbubbles from one system to the other demonstrates the presence of PSS with maximum accuracy. A study previously conducted in healthy dogs demonstrated that agitated saline is unable to cross the hepatic sinusoids (Gómez-Ochoa et al., 2010). Moreover, if this communication exists, even in cases where a small vessel is responsible for shunting or where the portal vascular tree is partially conserved, microbubbles should follow the circulation and appear in the heart (Gómez-Ochoa et al., 2010).
By performing the injection into the jejunal veins, the test can potentially reveal all types of PSS, including the most distal, such as those deriving from the mesenteric veins. This surgical disease can be misdiagnosed or confused during clinical and hematological investigation, with other non-operable illnesses. Until now, PSS has been diagnosed by means of different imaging modalities: ultrasonography (Santilli and Gerboni, 2003), intraoperative portography (Scrivani et al., 2001), scintigraphy (Daniel et al., 1991), helical CT scan (Zwingenberger et al., 2005), magnetic resonance (Bruehschwein et al., 2010) and very recently by agitated saline contrast study (Gómez-Ochoa et al., 2011). When the dog was referred to the hospital the most critical question posed by the owner was how to achieve diagnostic certainty as cheaply as possible. Thus it was hypothesized that, before performing portography, ICE might be helpful in detecting microbubbles injected via the same intravenous route used for the iodine contrast agent and venous pressure transducer. This single case demonstrates that ICE can theoretically be used to rule in/out the existence of all shunts without providing their location. It may give an intraoperative confirmation of a successful treatment only in cases where complete closure is tolerated, but remains a further diagnostic test when attenuation is recommended or in the presence of acquired shunts due to portal hypertension. However, ICE is a real-time information tool, simultaneous with the injection of microbubbles, which is safe and can be repeated, if needed, to provide the surgeon with immediate evidence either that he is identifying the shunt or that a double shunt is present (Szatmári et al., 2004) or even whether a branch of the shunt has been left out of the ligature (Lawrence et al., 1992). Moreover, the appearance of microbubbles in the right cardiac chambers constitutes an easily interpretable image. Intraoperative portovenography is a selective angiography and therefore allows precise identification of the shunt vessels. However, it takes time and can be exhausting due to the weight of the radiation shielding worn and further, if the patient has to be moved to a radiology unit there is the danger of loss of sterility. Other imaging methods commonly used include scintigraphy and contrast CT. The first is a non-invasive procedure which consents a preoperative rule-in diagnosis and a postoperative assessment of the persistence of PSS. On the other hand, it requires restraint in a gamma camera and isolation of the patient for at least 24 h after the procedure, and manipulation of radioactive contrast agents. The second is a highly accurate diagnostic method useful for preoperative planning and location, but therefore requiring further anesthesia. It can aid the surgeon especially to save time. It is also employed for follow-up to evaluate the expansion of the hepatic volume after surgical treatment (Stieger et al., 2007). In conclusion, ICE could be employed every time the surgeon needs to verify, in the operating setting, the complete closure of a PSS ruling out the presence of a second shunt, especially when lacking detailed information on number of vessels and location; and as a way of avoiding the need for intraoperative portovenography, with the aim of cutting surgery time and reducing exposure to ionized radiation. Nevertheless, the surgeon should be ready to perform portovenography in case of post-oclusion positive echo-contrast. To the authors’ knowledge, this is the first report in which agitated saline contrast echocardiography is used during the surgical treatment of PSS. In the present case, it was employed to verify whether the technique could be both useful and not exhausting: indeed, the technique passed on both counts.

Conflict of interest statement
No conflict of interest.

Appendix A. Supplementary data


References


