Transvenous retrograde portography for identification and characterization of portosystemic shunts in dogs

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Portosystemic shunts (PSSs) are common cardiovascular anomalies in dogs1 that may be congenital or develop secondary to portal hypertension.2 Per rectal portal scintigraphy and abdominal ultrasonography are 2 noninvasive methods commonly used to determine whether dogs do or do not have a PSS.3,4 However, definitive identification and anatomic characterization of PSSs in dogs is most often accomplished by direct examination during surgery or by means of contrast mesenteric portography.5,6 Mesenteric vein catheterization for contrast portography requires a celiotomy and is, therefore, usually performed immediately prior to surgical ligation or attenuation of the shunt.5,7

Transvenous retrograde portography (TRP) provides an alternative method of identifying and characterizing PSSs that does not require abdominal surgery. This technique may be particularly useful in dogs in which the diagnosis is in doubt because findings of per rectal portal scintigraphy and abdominal ultrasonography are discordant and in dogs in which a shunt is not identified during exploratory celiotomy, even though shunting is strongly suspected on the basis of results of preoperative testing. Transvenous retrograde portography also facilitates selective catheterization of the PSS, and the catheter that is inserted can be left in place in the lumen of the PSS to assist in identification of the shunt during surgery.

Transvenous retrograde portography has been described previously,8 but information regarding specifics of the technique and results in clinical cases is lacking. The purpose of this report is to describe a technique for TRP in dogs suspected to have a PSS and provide results for 20 dogs in which the procedure was performed.

**Technique**

Transvenous retrograde portography was performed if the diagnosis of portosystemic shunting was in question because results of per rectal portal scintigraphy and abdominal ultrasonography were discordant, if a suspected PSS could not be identified during abdominal ultrasonography or exploratory celiotomy, or if positioning of a catheter within the shunt was requested to facilitate intraoperative identification of the shunt.

For TRP, the dog was anesthetized and positioned in left lateral recumbency. The right jugular furrow was prepared for aseptic surgery. In dogs weighing < 10 kg (22 lb), an 8-F catheter introducer was inserted percutaneously, and a 7.5-F dual-lumen balloon-tipped catheter was then introduced into the right jugular vein. In dogs weighing > 10 kg, a venous cutdown was used to permit insertion of a larger balloon catheter.6

The jugular vein catheter was directed caudally in the cranial vena cava and then in a dorsal direction into the azygos vein. The catheter was advanced into the azygos vein as far as was possible until resistance was met. The balloon was then inflated as necessary to occlude the azygos vein. Occasionally, when a larger catheter was used, inflation of the balloon was unnecessary, as the catheter itself occluded the vessel lumen sufficiently.

Following occlusion of the azygos vein, radiographic contrast medium (1 to 2 mL/kg [0.45 to 0.9 mL/lb]) was injected by hand during continuous fluoroscopic evaluation. This injection typically resulted in retrograde filling of the intercostal and intervertebral veins. In addition, contrast medium commonly flowed in a retrograde fashion into the prehepatic portion of the caudal vena cava via the intervertebral veins. The entire injection was recorded on videotape.

Following injection of contrast medium into the azygos vein, the catheter was withdrawn into the cranial vena cava and then advanced caudally through the right atrium into the caudal vena cava. The catheter was advanced to a position immediately cranial to the diaphragm. It was imperative that the initial occlusion of the caudal vena cava and subsequent contrast injection be made immediately cranial to the diaphragm. If the occluding balloon was placed at or caudal to the level of the diaphragm, the ostia of shunts that entered the caudal vena cava cranial to the liver were sometimes occluded by the balloon, resulting in a false-negative result.

Once the catheter was positioned, the balloon was inflated enough to completely occlude the caudal vena cava. The total duration of occlusion was typically < 8 seconds. With the caudal vena cava occluded, contrast medium (1 to 2 mL/kg) was injected by hand during fluoroscopic evaluation. This injection resulted in retrograde filling of the abdominal portion of the caudal vena cava and any PSS. In dogs in which retrograde filling of the shunt was suboptimal (ie, definitive identification of the shunt was not possible and hepatic venous filling was not evident), positive-pressure ventilation (20 cm H2O for 5 to 8 seconds) during the injection resulted in improved retrograde filling of the caudal vena cava and shunt. Multiple injections were frequently required to obtain a high-quality study in some dogs. However, the total amount of iodine...
administered did not exceed 3,200 mg/kg (1,454 mg/lb) in any dog.

Once the shunt was identified, selective catheterization of the shunt was attempted. Selective catheterization was accomplished by probing the area of the junction of the PSS and the caudal vena cava with a flexible 0.035-in guide wire directed through a 3-F angled catheter. Once the guide wire was positioned in the shunt, catheters could be directed into position without difficulty. Selective catheterization with a balloon-tipped catheter allowed for more specific opacification of the shunt, providing more detailed anatomic information. Additionally, the configuration of the balloon-tipped catheter allowed for measurement of portal pressure both when the shunt was open and when it was occluded by the inflated balloon. Furthermore, selective catheterization of the shunt provided an opportunity to leave the catheter in the lumen of the shunt, facilitating intraoperative identification of the anomalous vessel. Once the vessel was identified and isolated at surgery, the catheter was removed. In dogs with multiple extrahepatic PSSs, occlusion of the prehepatic portal vessels and easily documented hepatic arterial flow, which was considered suggestive of portosystemic shunting. In 10 dogs in which the shunt was catheterized, occlusion of the prehepatic portal and portoazygos shunts, even though we could catheterize the mesenteric and accessory hepatic veins; the kidney is opacified because of previous contrast medium injection.

Results

Between 1997 and 2001, TRP was performed at the Texas Veterinary Medical Teaching Hospital on 20 client-owned dogs suspected of having a PSS. Dogs ranged from 5 months to 11.5 years old and weighed between 2.5 and 22 kg (5.5 and 48 lb). In 19 of the 20 dogs, results of per rectal portal scintigraphy were suggestive of a PSS. In the remaining dog, results of per rectal portal scintigraphy were normal, but abdominal ultrasonography revealed a small liver with few visible portal vessels and easily documented hepatic arterial flow, which was considered suggestive of portosystemic shunting. In 10 dogs (8 with single and 2 with multiple Extrahepatic PSSs), TRP was performed because shunts could not be identified during abdominal ultrasonography. In 2 dogs, TRP was performed because results of abdominal ultrasonography suggested that PSSs were intrahepatic, whereas the dogs’ signalment would have suggested an extrahepatic shunt would be most likely. In 7 dogs, all of which had intrahepatic shunts, TRP was performed to place a catheter in the shunt to facilitate intraoperative identification of the shunt.

A PSS was identified and characterized with TRP in 18 of the 20 dogs. In 1 dog in which results of TRP were normal, an exploratory celiotomy was performed, and a single extrahepatic PSS was identified and attenuated. In the other dog in which results of the TRP were normal (Fig 1), ultrasound-guided hepatic biopsy was performed. Histologic examination of biopsy specimens revealed moderate multifocal microvesicular vacuolar hepatopathy, and the dog was clinically normal 3 years after the procedure. Additionally, serum bile acids concentration and results of per rectal portal scintigraphy were normal 3 years later.

In the remaining 18 dogs, results of TRP were confirmed at necropsy or during an exploratory celiotomy. One dog had an isolated, single portoazygos shunt (Fig 2), 2 dogs had multiple extrahepatic shunts, including portocaval and portoazygos shunts (Fig 3), 8 dogs had a single extrahepatic portocaval shunt (Fig 4), and 7 dogs had an intrahepatic shunt (Fig 5).

The catheter was positioned in the anomalous vessel in 16 of the 18 dogs. In the remaining 2 dogs, which had multiple extrahepatic shunts, selective catheterization of the small vessels was not attempted. In 6 dogs (2 with single extrahepatic and 4 with intrahepatic shunts), even though we could direct a catheter into the PSS, we were unable to position the catheter well enough to occlude the vessel. Both dogs with single extrahepatic PSSs were Golden Retrievers with large shunts, and in both of these dogs, although we could catheterize the mesenteric and portal veins through the shunt, the size of the shunt precluded selective shunt occlusion. In the remaining 10 dogs in which the shunt was catheterized, portal pressure could be measured during shunt occlusion with a balloon-tipped catheter, and injection of contrast medium during shunt occlusion helped to further define the anatomy of the shunt (Fig 6). Selective catheterization and occlusion of the shunt was possible in only 3 of the 7 dogs with intrahepatic shunts; in the remaining 4, however, a catheter could be positioned in the shunt, even though the shunt could not be occluded with the catheter.

Occlusion of the azygos vein for the 5 to 7 seconds
required for TRP was not associated with any demonstrable alterations in systemic arterial pressure. Occlusion of the caudal vena cava and subsequent injection of contrast medium typically caused a 5- to 15-mm Hg reduction in mean systemic arterial pressure. The most substantial reductions in pressure were detected when positive-pressure ventilation was used to enhance the results of TRP. The reduction in mean arterial pressure resolved in all dogs almost immediately following deflation of the balloon catheter. In no patient did these hemodynamic changes necessitate intervention.

Discussion

The current gold standard for anatomic evaluation of the portal vasculature in dogs is contrast portography, and we were able to obtain high-quality contrast portograms with TRP in all 20 dogs described in the present report. Although technically successful, 1 portogram was misinterpreted, resulting in a false-negative result. Mesenteric angiography has traditionally been used for contrast portography in dogs suspected to have PSSs; however, although mesenteric angiography can be done percutaneously, it often requires a celiotomy for catheter placement. In addition, mesenteric angiography does not allow for selective catheterization of the shunt. Therefore, it does not allow for measurement of portal pressures, placement of a catheter to facilitate intraoperative shunt identification, or deployment of intravascular occluding devices, all of which can be performed during TRP.

Figure 2—Lateral (A) and ventrodorsal (B) TRPs from a dog with a portoazygos shunt. The inflated balloon (white arrow) of a balloon-tipped catheter is occluding the azygos vein, and contrast medium outlines the shunt (black arrows). On the ventrodorsal view, the shunt (black arrows) and its communication with the portal vein (PV) are readily apparent. The kidneys (K) are opacified because of previous contrast medium injection.

Figure 3—Lateral TRPs from a dog with multiple extrahepatic PSSs. A—A balloon-tipped catheter positioned in the caudal vena cava just cranial to the renal veins was used for injection of contrast medium. Notice the retrograde filling of multiple shunts (arrowheads) with subsequent opacification of the portal vein (arrow). B—A balloon-tipped catheter positioned in the azygos vein was used for injection of contrast medium. Notice the retrograde filling of multiple additional extrahepatic PSSs (white arrowheads).
In all dogs described in the report, contrast medium was injected into both the azygos vein and caudal vena cava. In the dog with the isolated single portoazygos shunt, the diagnosis could be made only following injection in the azygos vein. In the 2 dogs with multiple extrahepatic shunts, both portoazygos and portocaval shunts were readily identified following injection in the caudal vena cava; however, only the portoazygos shunts were obvious after injection in the azygos vein. In no case did azygos vein injection identify a single portocaval shunt.

In the single dog described in this report in which a shunt was not identified with TRP, review of the videotape of the procedure revealed that the balloon catheter had been positioned just caudal to the diaphragm. When the balloon was inflated, the point at which the PSS entered the caudal vena cava was occluded, resulting in a false-negative result. This emphasizes the importance of positioning the catheter cranial to the diaphragm prior to balloon inflation and contrast injection. Additionally, if caval occlusion is not adequate, positive-pressure ventilation should be employed to maximize the diagnostic quality of the study.

It has been suggested previously that in dogs with multiple extrahepatic portocaval shunts, portoazygos shunts develop only after caval banding. In the 2 dogs...
with multiple extrahepatic shunts described in the present report, both portocaval and portoazygos shunts were evident at the time of the initial examination. Neither of these dogs had undergone surgery previously, suggesting that portoazygos shunts can develop spontaneously.

Care must be used when measuring and interpreting portal pressures during TRP. First, although pressures can be measured with the balloon deflated and the shunt open, it should be realized that the simple presence of the catheter in the shunt may partially occlude the shunt, artificially elevating the measured portal pressure. Second, if during inflation the balloon expands eccentrically, the tip of the catheter may be partially obstructed by being displaced against the wall of the shunt, resulting in an erroneously high measured portal pressure. Third, because these dogs are often in a shallow plane of anesthesia and anesthetized for only a short time, measured portal pressures may be higher than those obtained during intraoperative mesenteric vein catheterization. We have not compared portal pressures obtained during TRP with pressures obtained by means of intraoperative mesenteric vein catheterization, and more experience will be required before any statements can be made regarding what should be considered normal portal pressures prior to shunt occlusion or what should be considered acceptable pressures after shunt occlusion in dogs undergoing TRP.

A major advantage of TRP in dogs suspected of having a PSS, compared with other methods for contrast portography, is that TRP does not require exploratory celiotomy. Results in this select population of dogs suggest that the procedure was associated with minimal risks of adverse effects or death. Although we do not suggest that TRP supplant abdominal ultrasonography or per rectal portal scintigraphy as preoperative diagnostic tests, our results do suggest that it may be a useful adjunct in some dogs with PSSs, particularly those in which anatomic characterization of a suspected PSS is incomplete and those in which localization of the shunt during surgery is difficult. The ability to selectively catheterize the shunt allows for measurement of portal pressures before and after transient shunt occlusion and may facilitate intraoperative identification of the PSS. Furthermore, techniques used during this procedure might one day facilitate transcatheter intravascular occlusion of PSSs in selected cases as appropriate occluding devices become available.

References