

Transvenous Retrograde Angiography for Detection of Portal-Caudal Caval Shunt

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ABSTRACT. A retrograde angiography method for the detection of a portosystemic shunt was studied. The retrograde angiography was done by compressing the caudal vena cava in the chest by applying pressure to the thoracic cavity, then feeding a contrast medium into the caudal vena cava without releasing the pressure loading. The angiography could detect shunt vessels in experimental cases as well as clinical cases. This method is useful for the confirmation of a portal-caudal caval shunt, which can be performed without technical difficulty and without the need for a special kind of catheter.—**KEY WORDS:** angiography, canine, portosystemic shunt.

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The existence of a portosystemic shunt is suspected from the clinical symptoms (e.g., neurological signs) or biochemical abnormalities (e.g., increased blood concentration of ammonia or total bile acids) [4, 5]. Generally, identification of a shunt vessel is achieved during surgery by angiographic examination via the portal vein [2, 4, 5]. This method is of little advantage, since its effect is limited to the detection of otherwise unobservable portosystemic shunts in the liver. We attempted to develop a method for angiographic detection of a portosystemic shunt without undertaking laparotomy. This paper describes a method for angiographic identification of a portal-caudal caval shunt which is the most frequent of all portosystemic shunts.

An experiment was carried out on three normal Beagle dogs and two adult mongrel dogs in which a portal-caudal cavae shunt had been experimentally produced in infancy. After more than 18 hr of fasting without water, the dogs were anesthetized with thiopental sodium. Anesthesia was maintained by inhalation of isoflurane via an endotracheal tube. The dogs were then held in a right lateral recumbent position. A 6Fr multipurpose tube (Atom) was inserted via the left saphenous vein and was advanced under radiographic observation cranially to the renal venous anastomosis of the vena cava and caudally to the hepatic venous anastomosis. To collapse the caudal thoracic vein by compression, the intrathoracic pressure was increased by manual compression of a respiration bag until the airway pressure was increased to 20–30 cmH₂O. When this was achieved, 1 ml/kg of Iohexol (Omunipaque 240, Daiichi Seiyaku) was introduced by bolus injection through the catheter. Immediately after injection, the flow of the contrast medium was either X-rayed or observed *in situ* by fluoroscopy.

In the normal Beagle dogs, the contrast medium filled the caudal vena cava and flowed back into the hepatic and renal veins. In the liver, even peripheral parts of the hepatic vein could be visualized (Fig. 1). In the dogs with an experimental shunt, the backflow of the contrast medium could be delineated not only in the hepatic and renal veins but also in the shunt vessel (Fig. 2). The shunt vessel could therefore be distinctly visualized in this angiography.

Visualization of the shunt vessel by retrograde angiography from the saphenous vein could thus be

confirmed. To test the safety of this method, its effect on the circulatory system was examined in six normal Beagle dogs. After the induction of anesthesia by the same method, the chest cavity was pressurized and a contrast medium was infused. The effects of pressure application and infusion of the contrast medium on the respiration, arterial pressure and electrocardiograms were examined. During pressure loading to the thoracic cavity, the depression of the arterial pressure and increase in heart rate that resulted was probably due to the decreased volume of venous return. When the pressure was released, these indices rapidly returned to normal. Observation was continued for a further 60 min but no abnormalities were detected. The safety of this diagnostic method was thus verified by the above results. Since clinical application was considered feasible, the method was tested on clinical cases with consent obtained from owners.

Case 1 was a male 5-month-old Labrador Retriever weighing 17 kg. The diagnosis of hepatic encephalopathy was established from the clinical signs and by blood tests.



Fig. 1. Retrograde angiogram of the caudal vena cava in a normal dog. The caudal vena cava in the thoracic cavity is compressed and the contrast medium fills the abdominal vena cava and flows back into the hepatic vein.



Fig. 2. Angiogram in a dog with experimental portal-caudal caval shunt. The contrast medium flowed back into the portal vein (arrow heads). The backflow into the hepatic vein is poorly contrasted when compared with Fig. 1.

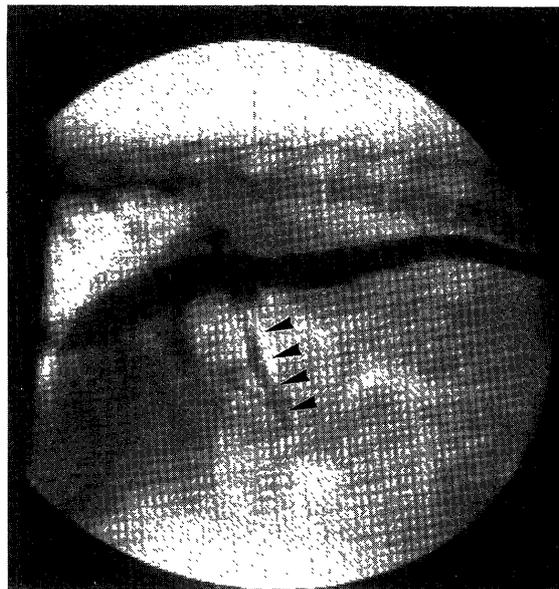


Fig. 4. Angiogram in Case 2. The contrast medium flowed back into the portal vein through a meandering shunt vessel (arrow heads). The backflow into the hepatic vein is not confirmed.

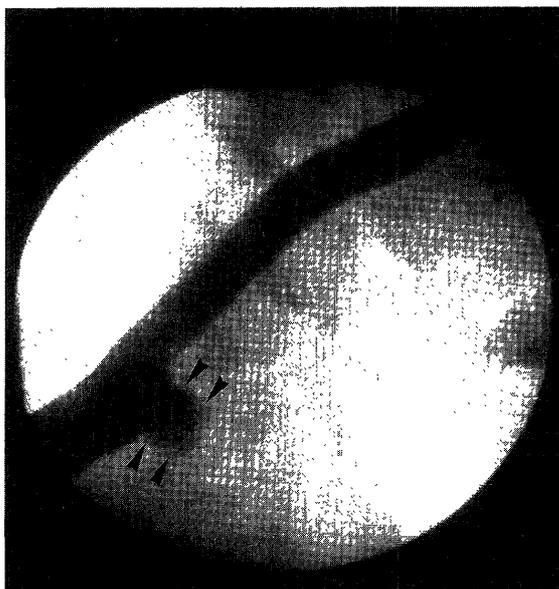


Fig. 3. Angiogram in Case 1. A thick shunt vessel is anastomosed to the caudal vena cava at the region of hepatic venous anastomosis (arrow heads). The contrast medium flow only a short distance back into the shunt vessel. The backflow into the hepatic vein is not seen in this photograph.

Angiography was performed by the method used in the experiment. The movement of the contrast medium was observed in situ by fluoroscopy and recorded on videotape. A large shunt vessel of the same thickness as the caudal vena cava was found anastomosed to the caudal caval anastomosis of the hepatic vein, and the hepatic vein was found to be poorly developed, but unlike the distinct visualization in the experimental dogs, the back-flow of

the contrast medium into the shunt vessel was only poorly visualized (Fig.3). Judging from the site of anastomosis, it was diagnosed as an intrahepatic shunt from the rudiment of the right ductus venosus [3, 4]. From the thickness of the shunt vessel, it seemed that a considerable portion of portal blood was shunted. It was confirmed at operation that a large intrahepatic shunt was present as suspected from the angiographic findings. The portal vein was only very meagerly distributed in the liver and most of the portal blood flowed through the shunt vessel.

Case 2 was an 8-month-old Yorkshire terrier weighing 2.2 kg. On suspicion of hepatic encephalopathy, the dog was brought to our hospital. Anesthesia was induced by the same method. Since the vessels of the hind legs were very thin, insertion of a multipurpose tube was difficult. Instead of a tube, an ordinary 22 gauge intravenous catheter was indwelt in the saphenous vein. Through this catheter, a contrast medium was injected at an increased dose of 2 ml/kg, because a larger amount was considered necessary to fill the abdominal vein. Angiography revealed the existence of a shunt vessel anastomosed almost halfway between the right renal and hepatic anastomoses of the caudal vena cava (Fig. 4). From the position of this anastomosis, it was diagnosed as a shunt which developed via the gastrosplenic vein [3, 4]. The backflow of the contrast medium into the hepatic vein was only poorly visualized. This made confirmation of distal branches of the hepatic vein difficult from the fluoroscopy images. At surgical closure of the shunt vessel, its existence visualized by angiography was confirmed.

Confirmation of a shunt vessel without undertaking laparotomy is highly advantageous in that it leads to the establishment of definitive diagnosis preoperatively and it

provides important data for the planning of surgery [1]. The difficulty in operating differs largely depending on the location (intra or extrahepatic) of the shunt. For intrahepatic shunt surgery, elaborate preoperative preparation is often needed, which includes temporary interruption of caval blood flow. If the location of the shunt is known preoperatively, surgery can be performed more easily. Advancement of a balloon catheter into a shunt vessel may be possible, once this vessel is identified preoperatively. It is therefore predicted that preoperative measurement of the portal pressure may become possible and that information to judge whether complete closure of the shunt vessel is possible or not can be obtained. Furthermore, a more reliable diagnosis may be possible.

A method for angiography of a shunt vessel by infusion of a contrast medium via the mesenteric artery through a catheter advanced to the cranial mesenteric artery has been earlier described as an attempt at angiographic detection of a shunt vessel without laparotomy [5]. It is difficult to obtain an image of sufficient contrast at the site of a shunt vessel. It is also technically more difficult than our method. The method proposed by us is to compress the caudal vena cava in the chest by applying pressure on the thoracic cavity, to feed a contrast medium into the caudal vena cava without releasing pressure loading and to retrogradely achieve angiographic visualization of a shunt vessel. The practicability of this method was established experimentally as well as clinically. The volume of contrast medium that flows back into a shunt vessel may vary with the intrathoracic pressure, volume of blood in it,

compliance of the shunt vessel, dose of the contrast medium or rate of infusion. The relatively small volume of backflow in Case 1 may be attributed to the relatively low dose of the contrast medium infused for the size of the shunt vessel that existed and to the large volume of blood flow in this vessel. But even though the volume of back-flow was small, the existence of the shunt vessel and the site of its anastomosis to the caudal vena cava could be confirmed. This may provide adequate diagnostic value for the method. The method has a disadvantage in not allowing detection of a portoazygos shunt, one of the congenital portosystemic shunts. Although the method requires some more refinement, it may be considered a useful technique for the confirmation of a portal-caudal caval shunt, which can be performed without technical difficulty and without the need for a special kind of catheter.

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