

## Successful Treatment by Percutaneous Transvenous Coil Embolization in a Small-breed Dog with Intrahepatic Portosystemic Shunt

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**ABSTRACT.** A Miniature Dachshund, 3-month-old, 3.1 kg, was diagnosed as an intrahepatic portosystemic shunt (PSS) with the shunting vessel in 6-mm diameter. Percutaneous transvenous coil embolization (PTCE) was performed with a stainless steel coil in 8-mm diameter. Intraoperative portal pressure elevated about 2.5 times after one-stage coil occlusion. Two weeks after the PTCE, serum bile acid levels reduced within the normal range. The portogram showed complete occlusion of the shunting vessel 4 months after the PTCE. Approximately 3 years after the PTCE, the patient has shown no clinical signs. PTCE could be performed more easily and less invasively in a small-breed dog. It is therefore suggested that PTCE is a promising therapeutic technique in canine intrahepatic PSS.

**KEY WORDS:** canine, coil embolization, portosystemic shunt.

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Congenital portosystemic shunts (PSS) are abnormal vascular communications between the portal vein and the systemic venous circulation, and are categorized as intrahepatic and extrahepatic type according to the location of the shunting vessel [1, 4, 5]. The surgical attenuation of the shunting vessel in dogs with congenital intrahepatic PSS is the treatment of choice, but is technically demanding and time consuming and depends greatly on the surgeon's skill and experience [2–5]. Especially, the conventional surgical techniques are associated with high complication rate and mortality due to their high invasiveness in the difficult cases of the identification and isolation of the intrahepatic shunt. In addition, they are more difficult due to the insufficient surgical field and small-sized vessels in small-breed dogs in comparison with large-breed dogs. The establishment of less invasive therapeutic safety procedure is therefore desirable in small-breed dogs with intrahepatic PSS.

Transvenous coil embolization is thought to be a less invasive and convenient therapeutic technique in congenital intrahepatic PSS. There are limited numbers of reports on the successful treatment using the transvenous coil embolization in the large-breed dogs [2–4]. However, transvenous coil occlusion in small-breed dogs with intrahepatic PSS has not been reported yet to the best of our knowledge. It is thus unclear whether clinical application of the coil occlusion is possible or not in small-sized dog. The purpose of this report is to demonstrate firstly the successful treatment by the percutaneous transvenous coil embolization (PTCE) in a small-breed dog with intrahepatic PSS and to inquire into the therapeutic potential of the PTCE in canine intrahepatic PSS in comparison with the previous reports.

A Miniature Dachshund, female, 3-month-old, 3.1 kg, was referred to the Nihon University Animal Medical Center with the unthriftiness and the neurological sign associated with hepatic encephalopathy, as the chief complaints.

Abnormalities on physical examination included syntexis and rough hair coat. Complete blood count showed mild anemia and microcytosis, and serum biochemical profile revealed that ammonia concentration was high (192  $\mu\text{mol/l}$ ). In addition, fasting and postprandial serum bile acid (SBA) levels were both elevated (fasting: 12.7  $\mu\text{mol/l}$ , postprandial: 189  $\mu\text{mol/l}$ ). Prothrombin time (PT) and activated partial thromboplastin time (APTT) mildly increased 8.6 sec and 19 sec, respectively, and anti-thrombin III activity (AT-III) was reduced 77%. Those findings suggested the mild impairment of blood coagulation. Abdominal radiography revealed the small liver, and abdominal ultrasonography indicated that intrahepatic portal vascularity was not well-defined and an abnormal single portal vessel was located in the small liver. Identification of an intrahepatic left-divisional shunt (patent ductus venosus) with 6-mm in diameter was confirmed by magnetic resonance angiography and mesenteric portography under the general anesthesia with isoflurane inhalation (Fig. 1). The histopathological findings of the liver biopsy showed mild perilobular accumulation of fibrous tissues, hyperplastic changes of hepatic arterioles, and indistinguishable portal vascular structure and bile duct. PTCE was chosen for the treatment of intrahepatic PSS, because higher mortality rates were expected with surgical ligation of the intrahepatic shunt.

The patient was sedated with butorphanol (0.2 mg/kg, IV) and midazolam (0.2 mg/kg, IV), and was anesthetized with isoflurane inhalation for the PTCE. The neck and abdominal skin were clipped and prepared aseptically. A mini-laparotomy was firstly performed, and a 24G over-the-needle catheter was placed into the mesenteric vein for the portographic guidance and portal pressure monitoring. The baseline (pre-embolization) portal pressure was 4.2 cmH<sub>2</sub>O. A 6F sheath introducer catheter was placed percutaneously into the right jugular vein, and a 5F multipurpose catheter

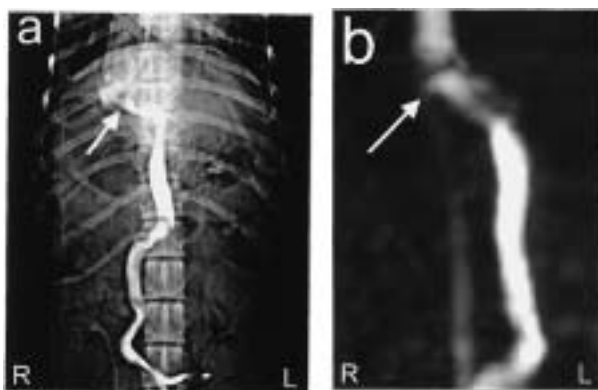


Fig. 1. Definitive diagnosis of intrahepatic portosystemic shunt (PSS). Ventrodorsal mesenteric portogram (a) and magnetic resonance angiogram (b) revealed the intrahepatic PSS. White arrows show the abnormal communication (shunt) between the portal vein and the caudal vena cava.

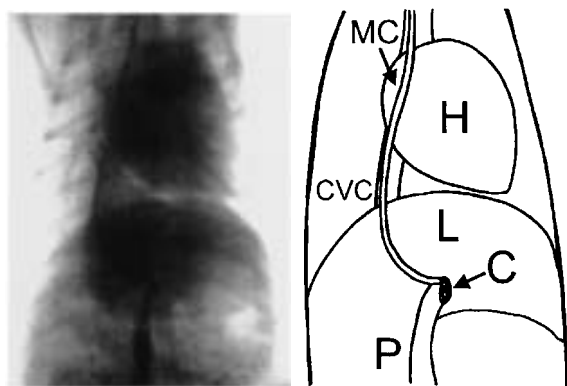


Fig. 2. Intraoperative fluoroscopic finding with mesenteric portography (left) and its scheme (right). The fluoroscopy showed that the coil is placed into the shunting vessel. C: coil, CVC: caudal vena cava, H: heart, L: liver, MC: multipurpose catheter, P: portal vein.

with a guide wire was inserted into the sheath. The multipurpose catheter was introduced to the shunting vessel under the fluoroscopic and portographic guidance using the guide wire without effort and technical demand. After the tip of the multipurpose catheter was into the shunting vessel was recognized, the guide wire was removed. PTCE was performed using the Jackson detachable coil delivery system (Cook, Bloomington, IN, U.S.A.). The delivery wire with a stainless steel coil, which was coated by Dacron fibers and was 8-mm in diameter and 5-cm in length with two rolls, was inserted through the multipurpose catheter. The coil was placed into the shunting vessel under the fluoroscopic and portographic guidance (Fig. 2), and was released with care of the color of visible intestines and excessive increase in portal pressure. When one coil was placed, the portal pressure was elevated 10.0 cmH<sub>2</sub>O in spite of no change in the color of visible intestines. The coil was consequently released, and no more coil occlusion was performed. The operative time from the insertion of the catheter to the removal was approximately 1 hr.

The patient showed no clinical signs and complications and had normal appetite and activity the next day after the PTCE. Abdominal radiography revealed no migration of the embolization coil as well as little increase in hepatic mass since the PTCE (Fig. 3). On the other hand, portal blood flow had a tendency to increase in the other liver lobes by color Doppler ultrasonography.

Fasting and postprandial SBA levels, which were elevated 31.0  $\mu\text{mol/l}$  and 231  $\mu\text{mol/l}$ , respectively 1 week before the PTCE, were reduced dramatically to less than 1.0  $\mu\text{mol/l}$  and 14.3  $\mu\text{mol/l}$ , respectively 1 week after. Approximately 2 months after the PTCE, fasting and postprandial SBA levels decreased under 1.0  $\mu\text{mol/l}$  and 8.9  $\mu\text{mol/l}$ , respectively and returned to within their normal ranges (< 10  $\mu\text{mol/l}$ ). Hyperammonemia on the first presentation (192  $\mu\text{mol/l}$ ) decreased to the normal range on the second presentation due to the medical treatment. Serum ammonia concentrations 1 week before the PTCE (38  $\mu\text{mol/l}$ ) and 1 week after (16  $\mu\text{mol/l}$ ) were within the normal ranges. The

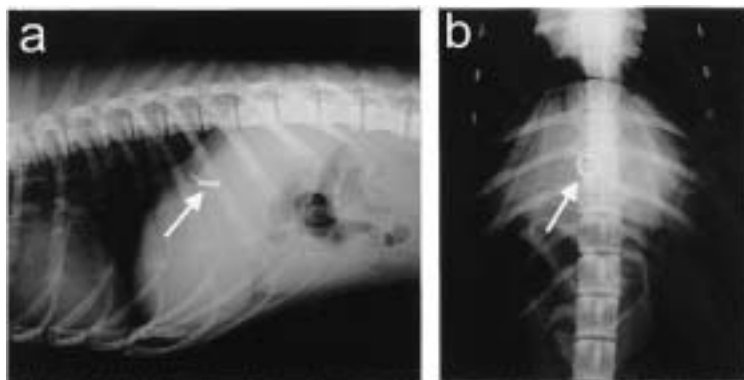


Fig. 3. Lateral (a) and ventrodorsal (b) radiogram 2 months after the percutaneous transvenous coil embolization. These radiograms showed no migration of the coil.

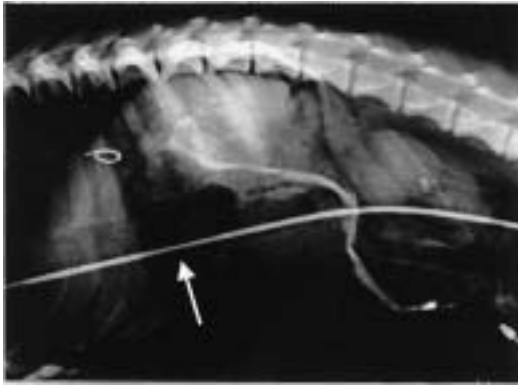


Fig. 4. Mesenteric portogram 4 months after the coil embolization. This portogram demonstrated the complete occlusion of the shunting vessel. Intrahepatic portal vascular dysplasia was also detected. White arrow shows the electrocardiogram lead.

improvement of the liver function has been thus indicated immediately after the PTCE was performed.

APTT and PT were reduced 11.0 sec and 7.4 sec, respectively 1 week after the PTCE. PT has kept within the normal range, while APTT increased slightly 1 month after the PTCE and then decreased within the normal level 4 months after. AT-III elevated 85 % 1 week after the PTCE and has kept within the normal range 1 month after. Blood coagulability was thus shown to be improved by the PTCE.

Medical treatment with lactulose, amoxicillin, and metronidazole was stopped approximately 1 month after the PTCE, and dietary management was discontinued about 2 months after. Four months after the PTCE, the mesenteric portography could be carried out in ovariohysterectomy with the owner's permission. The portogram revealed complete occlusion of the shunting vessel (Fig. 4). It also showed that the radiodensity of only a part of liver was enhanced by the transportal contrast media. The possible causes of this heterogeneous hepatic radiodensity were thought to be due to the intrahepatic portal vasculature dysplasia and the involvement of the branch of the original intrahepatic portal vessel by the coil occlusion. Four months after the PTCE, the patient had shown no clinical signs, no abnormalities of serum biochemical profile including the liver enzyme and serum liver functional profile had been recognized, and abdominal ultrasound had consistently revealed a tendency to increase in hepatic blood flow in all lobes by color flow Doppler. At the time of this writing, the patient has no clinical signs approximately 3 years after the PTCE.

This case has demonstrated that successful PTCE in a small-breed dog with intrahepatic PSS was performed more easily and safely and less invasively in comparison with the conventional surgical ligation. This excellent result was similar in the previous reports described on the PTCEs in 2 large-breed dogs (an Alaskan Malamute and a Golden Retriever) with patent ductus venosus [2, 3]. These evi-

dences therefore suggest that PTCE becomes a promising technique for the treatment of canine intrahepatic PSS.

The conventional surgical therapy has contained prehepatic or posthepatic shunting vessel ligation, parenchymal shunting vessel ligation, or intravascular attenuation in canine intrahepatic PSS [1, 4, 5]. In comparison with those techniques, the advantages of PTCE include gradual occlusion of the shunting vessel without sequential procedures, less invasiveness and complication, shorter period of anesthesia and hospitalization, and easy implantation of sequential coil if needed. In our case, only one PTCE carried gradual occlusion of the shunting vessel and resulted in complete occlusion without complication. The disadvantages of the PTCE however include the possibility of coil migration, the requirement of experience and knowledge on interventional radiology, inadequate evidences of therapeutic effectiveness of PTCE for any morphologic variations of intrahepatic PSS, and little establishment of the appropriate standardized conditions (e.g. number, size and shape of coil) for the PTCE.

Some differences could be indicated between our case and the previous 2 cases [2, 3] as follows. Firstly, our case was a small-breed dog in contrast to 2 large-breed dogs (an Alaskan Malamute and a Golden Retriever) in the previous reports [2, 3]. Secondly, only one coil in one operation was placed in our case in contrast to 4 coils in 4 separate operations [3] and 3 coils in 2 different operations [2] in the previous reports. Those differences are thought to be mainly associated with the diameter of shunting duct. The diameter of the shunting duct in our case (6-mm) was smaller than those (12-mm [3] and more than 8-mm [2]) in the previous cases. Commercially available embolization coils are limited to size and length. It may be more difficult for the one-stage PTCE to lead a successful occlusion in large dogs than small dogs. The ratio of the diameter of the coil to the shunting vessel in our case was approximately 1.33. This ratio was slightly larger than that (about 1.25) of the first coil to the shunting vessel in the previous case [3]. In addition, the previous report demonstrated that the first coil was carried and trapped into the lung [2]. It was then thought that the risk of coil migration was lowered and the potential of embolization by coil was higher in the small-breed dog. The appropriate diameter and length of embolization coil have not been however standardized yet and are controversial in veterinary interventional radiology.

In our case, PTCE was performed under the fluoroscopic and portographic guidance. Therefore, laparotomy was required. In the previous case [3], PTCEs were performed under the digital subtraction retrograde portographic guidance without laparotomy. The laparotomy was needed because the digital subtraction fluoroscopy could not be unfortunately used in our hospital. However, the change in the portal pressure and the color of the intestines were detectable during the catheterization of the mesenteric vein. Those evidences provided more objective and accurate information to decide whether sequential coil embolization was required or not. Mini-laparotomy and the catheteriza-

tion of the mesenteric vein may be useful in the PTCE until more accurate and convenient indices can be established.

In conclusion, this report may suggest that PTCE could be a successful and effective therapeutic technique in a small-breed dog with intrahepatic PSS. Although some unclear issues for the criterion of the appropriate procedure of PTCE remain, clinical application of PTCE is warranted.

#### REFERENCES

1. Center, S. A. 1996. pp. 802–846. *In*: Strombeck's Small Animal Gastroenterology, 3rd ed. (Guilford, W. G., Center, S. A., Strombeck, D. R., Williams, D. A. and Meyer, D. J., eds.), W. B. Saunders, Philadelphia.
2. Gonzalo-Orden, J. M., Altonaga, J. R., Costilla, S., Cordero, J. M. G., Millan, L. and Recio, M. A. O. 2000. *Vet. Radiol. Ultrasound*. **41**: 516–518.
3. Partington, B. P., Partington, C. R., Biller, D. S. and Toshach, K. 1993. *J. Am. Vet. Med. Assoc.* **202**: 281–284.
4. Tobias, K. M. 2002. pp. 727–752. *In*: Textbook of Small Animal Surgery, 3rd ed. (Slatter, D. ed.), W. B. Saunders, Philadelphia.
5. White, R. N., Burton, C. A. and McEvoy, F. J. 1998. *Vet. Rec.* **142**: 358–365.