The Veterinary Journal 199 (2014) 376–381

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Computed tomographic morphology and clinical features of extrahepatic portosystemic shunts in 172 dogs in Japan

K. Fukushima [a], H. Kanemoto [a], K. Ohno [a,*], M. Takahashi [a], R. Fujiwara [b], R. Nishimura [b], H. Tsujimoto [a]

[a] Department of Veterinary Internal Medicine, Graduate School of Agricultural and Life Sciences, University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan
[b] Department of Veterinary Surgery, Graduate School of Agricultural and Life Sciences, University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan

ARTICLE INFO

Article history:
Accepted 17 November 2013

Keywords:
Portosystemic shunt
Canine
Computed tomography
Portography

ABSTRACT

Canine extrahepatic congenital portosystemic shunts (EH-cPSS) are classified into several anatomical types, depending on the origin and termination of the shunt vessel. The aim of this retrospective study was to determine the proportion and clinical features of each anatomical shunt type in a population of dogs presented to a veterinary teaching hospital in Japan. Dogs diagnosed with EH-cPSS using computed tomographic (CT) portography were included ($n = 172$) and shunts were classified based on previous reports. Clinical data were collected from case records and analysed statistically. The most common anatomical type was the spleno-phrenic shunt ($n = 64$), followed by the spleno-azygos ($n = 38$), right gastric-caval ($n = 29$), spleno-caval ($n = 21$), right gastric-caval with caudal loop ($n = 9$), right gastric-phrenic ($n = 6$), colono-caval ($n = 3$), spleno-phrenic and azygos ($n = 1$), and porto-caval ($n = 1$) shunts. Spleno-phrenic and spleno-azygos shunts were diagnosed more frequently in older dogs than right gastric-caval and spleno-caval shunts ($P < 0.05$). The portal vein/aortic (PV/Ao) ratio was significantly larger in dogs with spleno-phrenic shunts than in dogs with spleno-azygos, right gastric-caval or spleno-caval shunts ($P < 0.05$). The PV/Ao ratio was significantly larger in dogs with spleno-azygos shunts than in dogs with right gastric-caval shunts. Dogs with spleno-phrenic shunts had significantly lower serum alkaline phosphatase activities than those with right gastric-caval or spleno-caval shunts. Dogs with spleno-phrenic shunts had significantly lower fasting ammonia concentrations than those with spleno-caval shunts.

Introduction

The reported prevalence of congenital portosystemic shunts (cPSS) in dogs is 0.06–0.2% (Center, 1996). Extrahepatic congenital portosystemic shunts (EH-cPSS) are commonly diagnosed in young, purebred, small breed dogs, such as Yorkshire terriers, Maltese terriers, Miniature Schnauzers and Cairn terriers, and are classified anatomically by their origin and termination. The four major shunt types are the spleno-caval, spleno-azygos, right gastric-caval and right gastric-azygos shunts (Szatmari and Rothuizen, 2006). Although some other types of shunt have also been reported, these are rare (Szatmari and Rothuizen, 2006).

Intraoperative mesenteric portography was formerly the most common method for the definitive diagnosis of EH-cPSS (Martin, 1993). Less invasive methods, such as ultrasonography (US) and computed tomographic (CT) portography, are now used more commonly (d'Anjou et al., 2004; Zwingenberger et al., 2005). In particular, CT portography is useful for preoperative diagnosis and surgical planning, reducing surgical morbidity and operating time (Frank et al., 2003). The anatomical classification of EH-cPSS in CT portography has been reported in detail and several novel types have been reported, including spleno-phrenic shunts (Nelson and Nelson, 2011). Spleno-phrenic shunts have a characteristic termination of the shunt vessel, which drains into the caudal vena cava (CVC) cranial to the liver (Nelson and Nelson, 2011).

Since the relationship between the different anatomical types of EH-cPSS and their clinical characteristics has not been fully evaluated, the aim of this study was to determine the proportions and clinical features of each anatomical shunt type by analysing case records from a veterinary teaching hospital.

Materials and methods

Case records from dogs diagnosed with EH-cPSS using CT portography at the Veterinary Medical Center at the University of Tokyo (VMC-UT) from April 2007 to November 2012 were included in this study. Clinical data collected included breed, age, sex, bodyweight and clinical signs related to the cPSS (seizures, depression, salivation, vomiting, blindness) at first presentation to VMC-UT. The results of laboratory tests, including fasting ammonia (NH_3), pre- and post-prandial serum bile acid (SBA), blood urea nitrogen, and serum glucose and albumin concentra-

* Corresponding author. Tel.: +81 358 415403.
E-mail address: aohno@mail.ecc.u-tokyo.ac.jp (K. Ohno).

http://dx.doi.org/10.1016/j.tvjl.2013.11.013
1090-0233/

tions, along with alanine aminotransferase and alkaline phosphatase (ALP) activities, were also documented. In dogs that underwent surgery, the difference in portal vein pressure before and after temporary occlusion of the shunt vessel, and the presence or absence of postoperative complications (post-ligation seizure, ascites, gastrointestinal congestion) within 3 weeks were noted.

Image analysis

All images were carefully reviewed by an experienced radiologist (KF) on open source software (Osiri X, Pixmeo). Anatomical shunt types were classified based on Nelson and Nelson (2011) and novel classifications were made as necessary. The portal vein diameter was measured on transverse images halfway between the entrance of the gastroduodenal vein and the right portal branch to the liver. The aortic diameter was measured on the same transverse images. The portal vein/aorta (PV/Ao) ratio was calculated using these values (Nelson and Nelson, 2011). If the portal vein was undetectable at the previously noted location, the PV/Ao ratio was considered to be zero. The presence or absence of uroliths was also recorded.

Statistical analysis

To evaluate the predisposition of EH-cPSS in each breed, all cases presented to VMC-UT during the study period were used as the reference population. The odds ratio and 95% confidence interval (CI) were calculated if the number of cases was at least six in each breed category. If the lower limit of the 95% CI was >1, this was considered to represent a significantly higher risk of EH-cPSS in the breed ($P < 0.05$).

To compare the clinical data for each anatomical shunt type, the Kruskall–Wallis test was used for statistical analysis and post hoc comparisons were performed using Dunn's multiple comparison tests. P values <0.05 were considered to be statistically significant. Groups of >10 cases for each morphologic classification were evaluated statistically.

Results

Records from 172 cases were analysed, consisting of 79 male dogs (29 neutered) and 93 female dogs (34 spayed). The median age was 22 months (range 2–116 months) and the median bodyweight was 3.1 kg (range 1–11.1 kg). Affected breeds and odds ratios are summarised in Table 1. Yorkshire terriers, Toy poodles, Papillons, Miniature Schnauzers and Norfolk terriers were at higher risk of having EH-cPSS ($P < 0.05$).

The most common anatomical type was the spleno-phrenic shunt ($n = 64$), followed by the spleno-azygos ($n = 38$), right gastric-caval ($n = 29$), spleno-caval ($n = 21$), right gastric-caval with caudal loop ($n = 9$), right gastric-phrenic ($n = 6$), colono-caval ($n = 3$), spleno-phrenic and azygos ($n = 1$), and porto-caval ($n = 1$) shunts. Individual breed numbers for each of the four most prevalent shunt types (spleno-phrenic, spleno-azygos, right gastric-caval and spleno-caval shunts) are shown in Table 2 and their clinical features are summarised in Table 3. Volume rendering images of representative examples of each of four shunt types (spleno-phrenic, right gastric-caval, colono-caval and spleno-azygos shunts) are shown in Figs. 1–4. Statistical analysis revealed a significant difference in age, PV/Ao ratio, fasting ammonia concentrations and ALP activities among the shunt types ($P < 0.05$).

Spleno-phrenic shunts were diagnosed at a significantly older age than right gastric-caval and spleno-caval shunts ($P < 0.001$). Spleno-azygos shunts were diagnosed at a significantly older age than right gastric-caval ($P < 0.05$) and spleno-caval shunts ($P < 0.01$; Fig. 5). PV/Ao ratios were significantly larger for spleno-phrenic shunts (median 0.83) than spleno-azygos (median 0.62; $P < 0.01$), right gastric-caval (median 0.55; $P < 0.001$) and spleno-caval (median 0.55; $P < 0.001$) shunts. Spleno-azygos shunts were associated with significantly larger PV/Ao ratios than right gastric-caval shunts ($P < 0.05$; Fig. 6). Dogs with spleno-phrenic shunts had significantly lower serum ALP activities than those with right gastric-caval and spleno-caval shunts ($P < 0.01$). Dogs with spleno-phrenic shunts had significantly lower fasting ammonia concentrations than those with spleno-caval shunts ($P < 0.01$).

Clinical data for dogs with other types of shunts that were each represented at least three times in the study population are shown in Table 4; since the number of dogs with each of these shunt types was small, statistical analysis was not performed on this set of cases.

Discussion

Spleno-phrenic shunts were the most frequent type of EH-cPSS in this population of dogs in Japan (37.2%). This is different from a previous report from North America, in which spleno-azygos shunts were the most frequent (32%), followed by spleno-caval (24%) and spleno-phrenic shunts (16%) (Nelson and Nelson, 2011). Since Miniature dachshunds and Toy poodles are popular in Japan and had relatively high frequencies of spleno-phrenic shunts (Table 2), geographical breed distribution or genetic bias might be responsible for this discrepancy.

Spleno-phrenic shunts were diagnosed at a significantly older age than right gastric-caval and spleno-caval shunts. Spleno-phrenic shunts also presented with significantly larger PV/Ao ratios than the other shunt types. The phrenic vein drains into the CVC caudal to the diaphragm and cranial to the liver, and readily collapses with each respiratory cycle. This could contribute to decreased shunt fraction and result in latent clinical signs and preserved portal vein size. Unfortunately, because no cases underwent scintigraphic evaluation in this study, the exact shunt frac-

Table 1
Number of dogs of different breeds and odds ratios for extrahepatic congenital portosystemic shunts.

Breed	*n*	Odds ratio (95% CI)
Yorkshire terrier[a]	28	4.10 (2.75–6.12)
Miniature dachshund	25	0.91 (0.60–1.39)
Toy poodle[a]	18	1.85 (1.14–3.00)
Shih Tzu	16	1.66 (0.99–2.77)
Papillon[a]	14	3.34 (1.94–5.73)
Miniature Schnauzer[a]	11	2.55 (1.39–4.68)
Chihuahua	11	0.90 (0.49–1.65)
Maltese	9	1.73 (0.89–3.38)
Norfolk terrier[a]	8	24.0 (12.4–46.2)
Pug	5	1.89 (0.78–4.57)
Pomeranian	4	ND
West Highland white terrier	3	ND
Others[b]	20	ND

CI, confidence interval; ND, not determined.
[a] Breeds with a significantly higher risk of extrahepatic congenital portosystemic shunt ($P < 0.05$).
[b] Crossbred ($n = 9$); Pembroke Welsh Corgi, Shetland sheepdog, Italian greyhound ($n = 2$ for each breed); Shiba, Miniature pinscher, Bolognese, Jack Russell terrier, Cairn terrier ($n = 1$ for each breed).

Table 2
Number of dogs of different breeds with each of the four most prevalent types of extrahepatic congenital portosystemic shunt.

	Spleno-phrenic	Spleno-azygos	Right gastric-caval	Spleno-caval
Yorkshire terrier	5	6	7	5
Miniature dachshund	12	3	3	2
Toy poodle	8	8	0	1
Shih Tzu	6	4	2	1
Papillon	6	3	1	0
Miniature Schnauzer	8	1	0	1
Chihuahua	7	0	3	0
Maltese	0	1	5	2
Norfolk terrier	1	4	2	1
Pug	2	1	1	0
Others	9	7	5	8
Total	64	38	29	21