Case Report

Canine Intrahepatic Portosystemic Shunt in a Poodle Toy: A Case Report

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Abstract

An 8-month-old intact female poodle visited Prasu Arthorn Animal Hospital, Mahidol University, due to disorientation, ptyalism, and vomiting. The clinical examination revealed normal findings, except for ataxia, intermittent head shaking, and a normal pupillary light reflex with anisocoria, dazzle reflex, and threat response. Biochemical parameter measurements showed high alkaline phosphatase, ammonia, and fasting serum bile acids with a low albumin value. Ultrasonography of the abdomen showed a small liver with uniformly markedly diffuse hyperechoic parenchyma and a strange vessel coming from the intrahepatic portal vein and curving into the left part of the liver before entering the caudal vena cava. A computerized tomography (CT) scan examination confirmed a single left divisional intrahepatic portosystemic shunt (IHPSS). Based on clinical and laboratory diagnosis (hemogram and biochemistry) and CT scan examinations, portosystemic shunt (PSS) was diagnosed. Medical treatments included a hepatic formula diet and lactulose (0.5 mL/kg three times a day). A significant improvement in clinical signs was observed within a month, suggesting that medical treatments might be beneficial before considering surgical interventions for PSS. This case emphasizes the need for a collaborative approach and regular follow-up care in managing canine IHPSS, and it underscores the urgent need for further research to enhance patient outcomes.

Keywords: A computerized tomography scan, Canine intrahepatic portosystemic shunt, Canine, Ptyalism

ภาวะความผิดปกติเส้นเลือดลัดข้ามตับในพุดเดิ้ล

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บทคัดย่อ

สุนัขพุดเดิลเพศเมียอายุ 8 เดือนที่ยังไม่ได้ทำหมัน ได้เข้ารับการรักษาที่โรงพยาบาลสัตว์ประศุอาทร มหาวิทยาลัยมหิดล เนื่องจากมีอาการสับสน น้ำลายไหลมาก และอาเจียน การตรวจร่างกายพบว่าปกติ ยกเว้นอาการเดินเซ การกระตุกศีรษะเป็นช่วงๆ และมีปฏิกิริยารูม่านตาต่อแสงปกติแต่รูม่านตาขนาดไม่เท่ากัน ทดสอบการกระพริบของตาเมื่อได้รับการกระทบจากไฟที่สว่างจ้าปกติ และประเมินการมองเห็น การวัดค่าทางชีวเคมีพบว่า ค่าอัลคาไลน์ฟอสฟาเตส แอมโมเนีย และกรดน้ำดีในซีรั่มขณะอดอาหารสูง ในขณะที่ค่าอัลบูมินต่ำ การตรวจอัลตราซาวด์ช่องท้องพบตับขนาดเล็กและเนื้อตับมีความทึบแสงสูงอย่างสม่ำเสมอทั่วทั้งตับ นอกจากนี้ยังพบหลอดเลือดผิดปกติที่โค้งเข้าสู่ส่วนซ้ายของตับจากหลอดเลือดพอร์ทัลในตับก่อนเข้าสู่หลอดเลือดดำใหญ่ส่วนท้อง การตรวจด้วยเครื่องเอกซเรย์คอมพิวเตอร์ พบภาวะเส้นเลือดลัดข้ามในตับทางด้านซ้าย จากการวินิจฉัยทางคลินิกและการตรวจทางห้องปฏิบัติการ (การตรวจนับเม็ดเลือดและชีวเคมี) รวมถึงการตรวจเอกซเรย์คอมพิวเตอร์ สรุปได้ว่าเป็นภาวะความผิดปกติเส้นเลือดลัดข้ามตับ การรักษาทางยาประกอบด้วยอาหารสูตรสำหรับตับและให้ยาแล็กทูโลสขนาด 0.5 มล./กก. วันละ 3 ครั้ง ภายใน 1 เดือนพบว่าอาการทางคลินิกดีขึ้นอย่างมีนัยสำคัญ ซึ่งบ่งชี้ว่าการรักษาทางยาอาจเป็นประโยชน์ก่อนพิจารณาการผ่าตัดสำหรับภาวะเส้นเลือดลัดข้ามตับ กรณีนี้เน้นย้ำถึงความจำเป็นในการใช้วิธีการรักษาแบบร่วมมือกันและการติดตามผลอย่างสม่ำเสมอในการจัดการภาวะความผิดปกติเส้นเลือดลัดข้ามตับในสุนัข ซึ่งชี้ให้เห็นถึงความสำคัญของการวิจัยเพิ่มเติมเพื่อปรับปรุงผลลัพธ์ของสัตว์ป่วยต่อไป

คำสำคัญ : การตรวจวินิจฉัยโรคด้วยเครื่องเอกซเรย์คอมพิวเตอร์ ความผิดปกติเส้นเลือดลัดข้ามตับในสุนัข สุนัข น้ำลายไหล

Introduction

Canine intrahepatic portosystemic shunts (IHPSS) are birth defects in the blood vessels that cause the portal and systemic circulations in the liver to not connect properly (Van den Bossche and Van Steenbeek 2016). These problems send portal blood flow away from the liver, around the hepatic sinusoids and hurting the liver's ability to break down food and remove toxins (Ferrell et al., 2003). Unlike extrahepatic shunts located outside the liver, intrahepatic shunts are situated within the liver parenchyma (Ettinger et al., 2016). Although IHPSS are less common in small-breed dogs than extrahepatic shunts (Winkler et al., 2003), they are harder to diagnose and treat because of how complicated they are anatomically and how their symptoms vary.

Signs of hepatic encephalopathy (HE) can range from obvious to subtle and are often associated with abnormal behavior. More prominent central nervous system (CNS) signs include ataxia, unresponsiveness, pacing, circling, blindness, seizures, random barking, and coma (Ettinger et al., 2016). Approximately 30% of affected dogs exhibit gastrointestinal (GI) signs such as vomiting, diarrhea, anorexia, pica, and GI bleeding (melena/hematemesis) (Weisse et al., 2014). Ptyalism is thought to be a manifestation of HE or GI upset. Additionally, some pets may present with signs of lower urinary tract disease, including hematuria, stranguria, pollakiuria, or urethral obstruction (Berent and Weisse 2007). Due to decreased urea production, increased ammonia excretion, and decreased uric acid metabolism, ammonium urate calculi or debris formation is common in dogs with hepatic encephalopathy (Caporali et al., 2015). These signs may occur episodically or progress gradually, with severity influenced by factors such as shunt size, location, and degree of portal blood diversion (Konstantinidis et al., 2023). Diagnosis typically involves a combination of imaging modalities such as ultrasonography, computed tomography (CT), and selective angiography (Spies et al., 2024), along with functional assessments like serum bile acid and ammonia testing shunts (Winkler et al., 2003).

Several factors influenced the decision to treat IHPSS medically rather than surgically in this case. Medical management, including dietary modifications and medications such as lactulose, aims to control clinical signs and minimize hepatic encephalopathy shunts (Winkler et al., 2003). This approach can provide significant symptomatic relief and improve the quality of life, particularly in cases where surgical intervention may pose high risks or is not feasible due to the patient's overall health status (Favier et al., 2020).

Surgical treatments, on the other hand, like shunt attenuation or occlusion, can be curative but come with risks like portal hypertension and need precise anatomical localization and technical know-how (Mehl et al., 2007). Different types of surgery, like partial ligation and ameroid ring constrictor placement, have had different levels of success. Some studies have shown that controlled and predictable attenuation methods have better long-term results (Mehl et al., 2007). However, surgery might not always be a viable option due to factors such as the patient's age, comorbidities, or owner preference (Plested et al., 2020).

Moreover, the management criteria for extrahepatic portosystemic shunts (EHPSS) differ from those for IHPSS. EHPSS, being located outside the liver, are often easier to access and treat surgically. They are more common in small breeds and may present with less severe clinical signs than IHPSS, making surgical correction more straightforward (Weisse et al., 2014). In contrast, IHPSS require a more nuanced approach due to their intrahepatic location and potential for more severe hepatic dysfunction (Berent and Weisse 2007).

Treatment options for canine IHPSS include medical management to control clinical signs and minimize hepatic encephalopathy and interventional procedures such as surgical attenuation or occlusion of the shunt (Mehl et al., 2007). Treatment choice depends on factors such as shunt size, location, concurrent hepatic anomalies, and overall patient health. Despite advancements in diagnostic imaging and therapeutic techniques, managing PSS in dogs remains challenging, emphasizing the need for further research to optimize patient outcomes. This case report examines the diagnosis, follow-up, and treatment of IHPSS in dogs without surgical intervention.

Case description

Signalment and chief complaints

An 8-month-old puppy Poodle presented at Prasu Arthorn Animal Hospital with clinical signs of ptyalism and vomiting.

History taking

According to the owner's history, the puppy experienced ptyalism and vomiting once after consuming a snack containing a cannabis component (terpene). The puppy also has a history of previous seizures and received rectal diazepam treatment at another clinic before coming to Prasu Arthorn Animal Hospital. Additionally, the dog has lateral patella luxation in both hindlimbs.

Physical examination

Clinical examination revealed disorientation, ataxia, 5% dehydration, a body condition score (BCS) of 2/9, hypersalivation, normal capillary refill time (<2 seconds), normal heart sounds, clear lung sounds, a heart rate of 150 beats per minute, a respiratory rate of 35 breaths per minute, no abdominal discomfort, a rectal temperature of 100°F, and a systolic blood pressure of 130 mmHg by doppler device. The pupillary light reflex was responsive with equal pupil size (isocoria), and both dazzle and menace responses were positive. Proprioceptive deficits were noted in the right forelimb and both hindlimbs, with delayed responses. The puppy also exhibited intermittent head shaking and head pressing.

Laboratory results

Complete blood count (CBC) revealed leukocytosis with neutrophilia (Table 1). Biochemical analysis showed elevated levels of alkaline phosphatase, ammonia, fasting serum bile acid, and decreased albumin levels (Table 2). The coagulation profile was normal. All other laboratory values were within normal limits. The signalment, physical examination findings, and laboratory results collectively suggest dysfunction within the hepatobiliary system.

Ultrasonography

Ultrasonography was initially performed, revealing that the liver appears small with a homogeneously markedly diffuse hyperechoic parenchyma in all lobes. The portal vein to aorta ratio was within normal limits, calculated as 0.77. An aberrant vessel originating from the intrahepatic portal vein and curving into the left portion of the liver before entering the caudal vena cava (CVC) was observed (Figure 1). Turbulent flow revealed a mosaic pattern in color mode at the communication site with the shunt and the CVC. The maximum portal blood flow velocity was measured at around 17.6 cm/sec, while the mean portal blood flow velocity was within normal limits (30 cm/sec). The urinary bladder appeared moderately distended with clear (anechoic) urine, and the wall thickness was within normal limits. Both kidneys exhibited a homogeneously hyperechoic cortex with a slight reduction noted at the corticomedullary (CM) junction.

Table 1. Hematological result.

Parameter	Day 0 (26/12/66)	Day 23 (18/1/67)	Day 65 (29/2/67)	Day 82 (27/3/67)	Reference range
WBC	18.14	12.64	12.88	19.03	6-17 10^3/μL
Monocyte	1.4	1	1	1.5	0.2-1.7 10^3/μL
Neutrophil	14.3	10	10.1	15	3.6-13 10^3/μL
Lymphocyte	2.3	1.6	1.6	2.5	0.7-5.1 10^3/μL
Eosinophil	0	0	0	0	0.1-1.7 10^3/μL
Basophil	0	0	0	0	0-0.2 10^3/μL
Band neutrophil	0	0	0	0	0-0.5 10^3/μL
RBC	8.04	6.82	7.16	6.96	5-9 10^6/μL
Hb	16.0	13.1	12.5	13.0	10-18 g/dL
Hct	48.9	40.7	40.8	39.0	35-55%
MCV	60.8	59.7	57	56.0	60-77 fL
MCH	19.9	19.2	18.9	18.7	20-25 pg
MCHC	32.7	32.2	33.1	33.3	32-36 g/dL
PLT	206	136	219	216	200-500 10^3/μL
RDW	14.2	13.2	12.8	13.0	12-15%

WBC: white Blood Cell, RBC: red blood cell, Hct: hematocrit, Hb: hemoglobin, MCV: mean corpuscular Volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, PLT: platelet, RDW: Red Cell Distribution Width.

Table 2. Blood chemistry result.

Parameter	Day 0 (26/12/66)	Day 23 (18/1/67)	Day 65 (29/2/67)	Day 82 (27/3/67)	Reference range
ALT	57	72	73	41	10-100 U/L
ALP	306	217	318	370	23-212 U/L
Creatinine	0.77	0.59	0.58	0.67	0.5 - 1.8 mg/dL
BUN	12	5	5	4	7-27 mg/dL
Albumin	2.6	2.3	2.2	2.2	2.7-3.8 g/dL
Total Protein	5.5	4.5	4.8	4.7	5.2-8.2 g/dL
Glucose	108	87	89	86	77-125 mg/dL
Ammonia	187	-	34	46	0-98 umol/L
Pre-prandial Bile acid	100.5	-	141.2	-	0-14.9 umol/L
APTT	11.3	-	-	-	8.5-18.5
PT	9.2	-	-	-	3.5-7.5
TT	20.9	-	-	-	11.3-28.1

BUN: blood urea nitrogen, ALT: alanine aminotransferase, ALP: alkaline phosphatase, PT: Prothrombin time, APTT: activated thromboplastin time, TT: thrombin time.

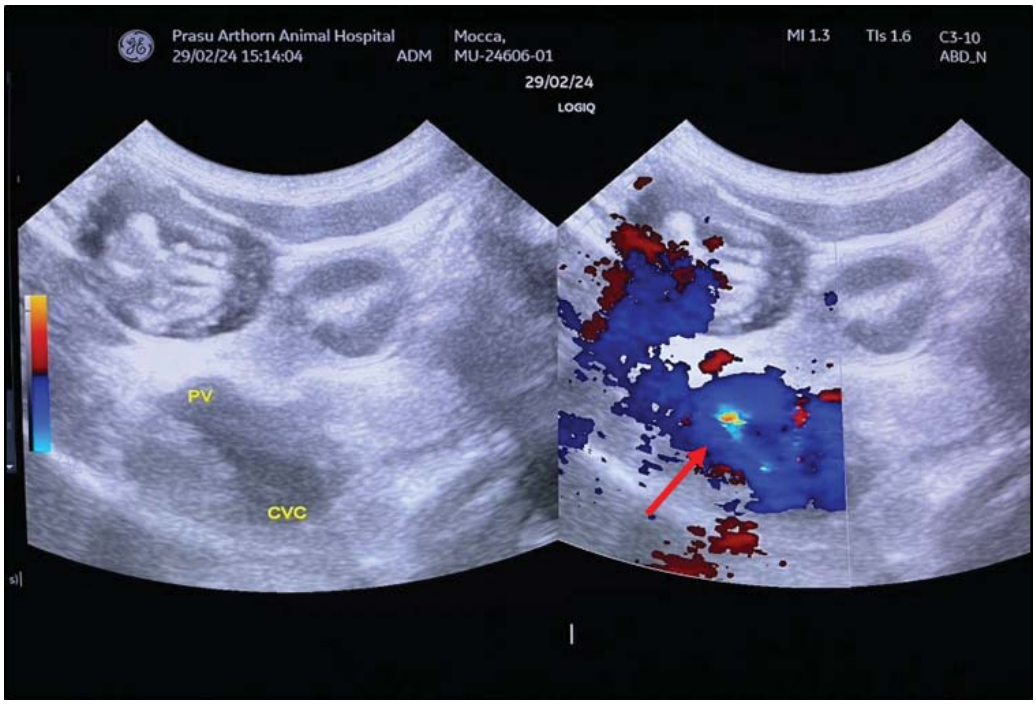


Figure 1. Abdominal ultrasonography revealed an anomalous vessel originating from the intrahepatic portal vein and coursing towards the left portion of the liver before joining the caudal vena cava (CVC). Turbulent flow was observed (red arrow), displaying a mosaic pattern in color mode at the communication site with the shunt and the CVC.

Computed tomography (CT) scan

Subsequently, a computed tomography (CT) scan was conducted to confirm the diagnosis. A single left divisional IHPSS was detected, characterized by abnormal communication between the portal and systemic circulations. This anomaly was presented as a single dilated looping vessel branching off the left intrahepatic portal vein, which was then inserted into the left phrenic vein and joined with the caudal vena cava (CVC). The tentative diagnosis was left divisional IHPSS (Figures 2 and 3).

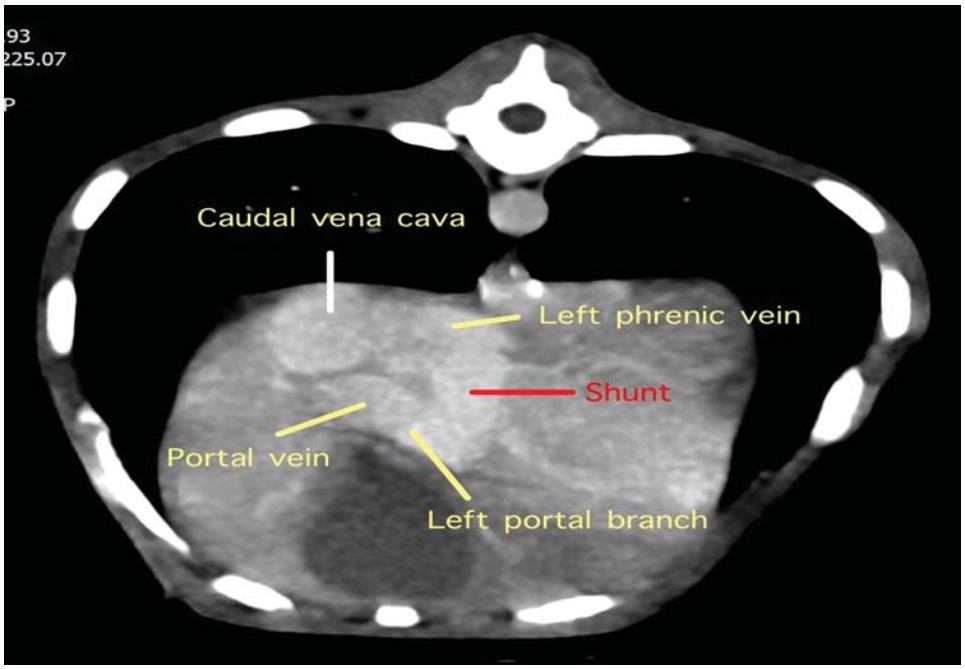


Figure 2. A CT scan (axial view) indicated a left divisional IHPSS (red letter).

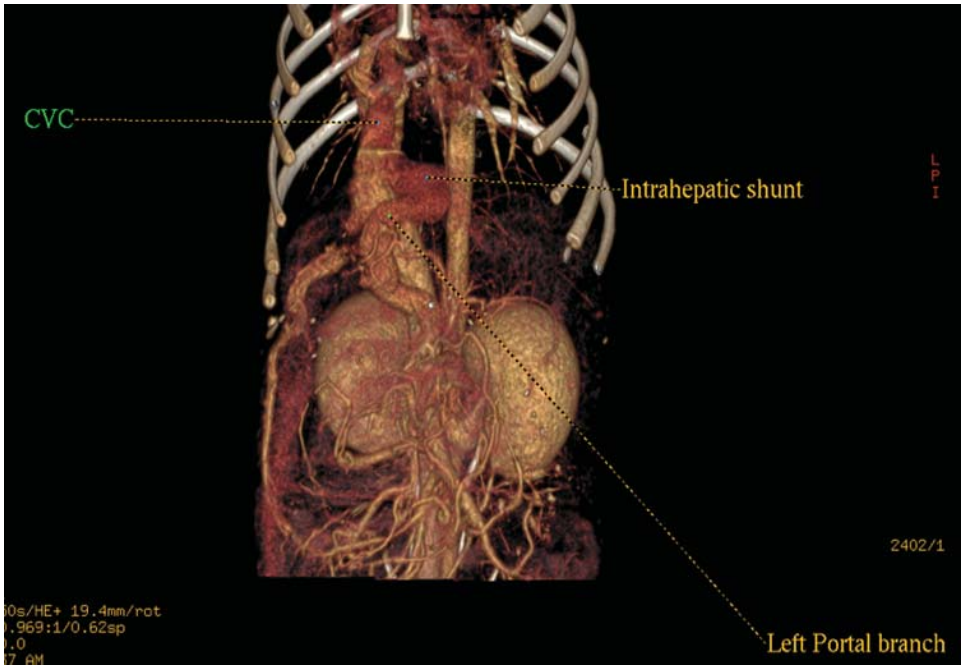


Figure 3. The three-dimensional computed tomography (CT) result revealed an anomalous communicating shunt between the portal and systemic circulation. This anomaly appeared as a single dilated looping vessel branch originating from the left intrahepatic portal vein, inserted into the left phrenic vein, and communicating with the caudal vena cava (CVC).

Treatment

The puppy was treated with a subcutaneous injection of ondansetron (Onsia®) at 0.5 mg/kg and a rectal enema with lactulose (Hepalac, Osoth interlaboratory CO., LTD., Thailand) administration (3 ml in 7 ml of normal saline) during the first visit. Lactulose was administered at 0.5 mL/kg up to three times daily for one month, and a hepatic formula diet (Hepatic, Royal Canin, Aimargues, France) was prescribed. Nutritional management was calculated as 1.6 times the resting energy requirement (RER) based on the puppy's ideal weight due to the puppy's low BCS. Despite two days of treatment, the puppy continued to exhibit vomiting and ptyalism, leading to further administration of rectal enema with lactulose and ondansetron.

After a three-week follow-up, the dog showed improvement in clinical signs, including ptyalism, vomiting, and neurological signs. The CBC and blood chemistry were rechecked, revealing thrombocytopenia, increased ALP, low blood urea nitrogen (BUN), hypoproteinemia, and decreased albumin levels (Table 2). Monthly follow-ups were conducted, with rechecking of clinical signs of hepatic encephalopathy (HE), including vomiting, ptyalism, head pressing, and intermittent head shaking, as well as monitoring body weight, BCS, CBC, and blood chemistry (Table 2).

Since the initiation of treatment with hepatic dietary and lactulose, the dog has not shown any recurrence of clinical signs. However, blood chemistry still revealed hypoproteinemia, hypoalbuminemia, decreased BUN, and elevated pre-prandial bile acid. Ammonia levels significantly decreased after the dog received hepatic dietary and lactulose. Despite an increased RER, the puppy's BCS and body weight did not improve.

Discussion

The presented case report describes an 8-month-old intact female puppy poodle with clinical signs suggestive of HE due to a single left divisional IHPSS. The diagnosis was supported by clinical examination, biochemical parameters, abdominal ultrasonography, and computed tomography (CT) scan findings. Treatment with a hepatic formula diet and lactulose resulted in significant clinical improvement within a month. Canine IHPSS are congenital vascular anomalies that divert portal blood flow from the liver, compromising its metabolic and detoxification functions (Ferrell et al., 2003, Van den Bossche and Van Steenbeek 2016). The clinical presentation can vary widely, with typical signs of HE, such as ataxia, unresponsiveness, pacing, circling, and seizures (Ettinger et al., 2016). Additionally, approximately 30% of affected dogs may exhibit GI signs, including vomiting and diarrhea (Weisse et al., 2014). The amount of cannabis snack consumed by the puppy was insufficient to cause a terpene overdose (Wakshlag et al., 2020).

The prevalence of IHPSS in small dogs has been reported at 7%, with previous studies ranging from 10 to 153 dogs (Hunt 2004). This condition has been identified in Toy and Miniature Poodles, Silky Terriers, Maltese, Pomeranians, Staffordshire Bull Terriers, and Scottish Terriers (Hunt 2004).

The diagnostic evaluation of PSS encompasses a comprehensive assessment of hematological, biochemical, urinary, and liver function parameters. Hematological findings commonly include microcytic anemia, which may result from various factors such as defective iron-transport mechanisms, decreased serum iron concentrations, decreased total iron-binding capacity, and possibly increased hepatic iron stores in Kupffer cells (Bunch et al., 1995; Simpson et al., 1997). In this case, hematological parameters were within the normal limits, with hematocrit (HCT) at 48%

(reference range 35-55 %), but mean corpuscular volume (MCV) was lower than the standard limit, with an average of 58 fL (reference range 60-77 fL)

Serum biochemical profiles frequently reveal decreased hepatic synthesis, characterized by low albumin and BUN levels, hypocholesterolemia, and hypoglycemia (Bunch et al., 1995). Additionally, mild to moderate increases in ALP and ALT activities are common. Serum bile acids (SBAs) and blood ammonia levels serve as crucial markers for liver function assessment, with increased postprandial SBAs and blood ammonia concentrations being highly sensitive and specific for detecting PSS (Van Straten et al., 2015). Urinalysis in congenital Portosystemic Shunts (cPSS) often shows low urine specific gravity (USG) and ammonium biurate crystalluria (Caporali et al., 2015). USGs are likely a consequence of polyuria/polydipsia (PU/PD) and the compromised medullary concentration gradient that arises from BUN levels due to an inefficient urea cycle. Proteinuria is common in canines PSSs, potentially secondary to glomerulopathy (Tisdall et al., 1996). The blood chemistry panel, including ALP, pre-prandial bile acid, total protein, albumin, and BUN, was consistent with previous reports (averages were ALP = 302 reference range 23 - 212 U/G, Pre-prandial bile acid = 120 umol/L reference range 0-14.9 umol/L, TP = 4.8 reference range 5.2-8.2 g/dL, albumin = 2.3 reference range 2.7-3.8 g/dL, BUN = 6.5 reference range 7-27 mg/dL) (Konstantinidis et al., 2023). No clinical signs of urination disorders such as PUPD, crystalluria, or stranguria were observed.

The previous report comparing soy protein isolate versus meat-based low-protein diets in dogs with cPSS offers valuable insights into dietary management strategies. The study's findings suggest that a soy-based diet may offer benefits in terms of reducing plasma ammonia levels and improving liver function parameters (Proot et al., 2009). These findings could be particularly relevant for long-term management or pre-surgical preparation of dogs with PSS, warranting further exploration of dietary interventions tailored to individual patient needs.

Another study highlighted the outcomes of non-surgical treatment approaches, either dietary management alone or in combination with lactulose, in dogs with cPSS (Favier et al., 2020). The study reported significant improvements in quality of life and clinical performance with non-surgical treatment, with an estimated median survival time of 3.2 years for non-surgically treated dogs. This reinforces the potential benefits of medical management as a viable option, especially when surgical intervention is not feasible.

A study compared the efficacy of two surgical approaches, partial ligation (PL) and ameroid ring constrictor (ARC) placement, in managing left-divisional IHPSS in dogs (Mehl et al., 2007). The analysis revealed that partial ligation offered more controlled and predictable attenuation compared to ARC placement, resulting in superior long-term outcomes. While both techniques exhibited similar short-term morbidity and mortality rates, PL emerged as the preferred treatment option for achieving favorable long-term outcomes in dogs with left-divisional IHPSS.

CT angiography (CTA) offers several advantages in evaluating IHPSS. It provides detailed anatomical information for accurate classification and surgical planning by identifying shunt insertion points into hepatic or phrenic veins. This enhances the consistency and reliability of IHPSS classification compared to ultrasonography or mesenteric portovenography (Plested et al., 2020). CTA also detects additional vascular anomalies and small vessels not visible with other modalities, aiding in complex shunt identification and surgical planning. Three-dimensional reconstruction

further enhances understanding of the shunt's relationship with surrounding tissues (Plested et al., 2020). However, CTA has drawbacks, including variability in contrast protocols across institutions, affecting image quality and consistency. Differences in injection rates, scan timing, and contrast opacification can lead to small vessel detection and evaluation accuracy variations. Additionally, reliance on pre- and post-contrast imaging may not capture dynamic blood flow through shunts, which is better assessed with intraoperative techniques like mesenteric portovenography.

Dogs with intrahepatic IHPSS treated non-surgically, survival outcomes reveal a moderate prognosis. In a cohort of 78 dogs with cPSS treated with non-surgical methods, the subgroup with IHPSS exhibited an estimated median survival time (EMST) of 26.5 months. This treatment typically involved a diet restricted in protein, sometimes supplemented with lactulose. Despite the relatively moderate survival expectancy, non-surgical treatment remains a viable option for managing clinical symptoms when surgical intervention is not feasible (Favier et al., 2020).

Hematology and blood chemistry parameters are significant prognostic factors for survival time in dogs with CPSS. Elevated blood ammonia levels, increased bile acids, and elevated liver enzymes such as ALT and ALP are crucial indicators of the liver's reduced capacity to detoxify blood due to the shunt. High blood ammonia levels are closely linked to hepatic encephalopathy, a significant factor in reducing quality of life and survival time. Increased bile acid concentrations and elevated liver enzymes indicate impaired liver function and ongoing liver damage, respectively, both of which contribute to a poorer prognosis. Additionally, hypoproteinemia and hypoalbuminemia can indicate severe hepatic impairment, further reducing survival times (Greenhalgh et al., 2014, Favier et al., 2020).

In conclusion, the prognosis for these cases was poor as the blood chemistry worsened progressively with each monthly follow-up. Managing canine IHPSS challenging due to their complex nature and variable clinical presentations. This case highlights the importance of a comprehensive diagnostic approach, including advanced imaging techniques and a tailored treatment strategy based on individual patient needs. Further research, particularly in dietary management and non-surgical treatment options, is essential to optimize patient outcomes and enhance our understanding of this complex condition.

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