Case Report

Feline Portosystemic Shunts: A Case Report

Poonnut Darakamas[1*] Panyakamol Chandrasakha[1] Sukanya Maneein[2]
Rungrote Osathanon[2] Pasakorn Brikshavana[3] Krittin Chuaychoo[1]
Namphung Seumanotham[2]

[1]Prasuarthon Animal Hospital, Faculty of Veterinary Sciences, Mahidol University,
Phuttamonthon 4 Rd., Salaya, Nakhon Pathom 73170, Thailand
[2]Department of Veterinary Clinical Sciences and Public Health, Faculty of Veterinary sciences, Mahidol University,
Phuttamonthon 4 Rd., Salaya, Nakhon Pathom 73170, Thailand
[3]Kaewkarn Animal Hospital,
Bang Na-Trat Road., Bangkaew sub-district, Bangphe district Samutprakarn 10540, Thailand

[*]Corresponding author, E-mail address: poonnut.dar@mahidol.edu

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Abstract

A 4 kg, 3 year-old, spayed female, Persian cat was presented at Prasuarthon Animal Hospital, Faculty of Veterinary Science, Mahidol University with the clinical sign of ptyalism for the past year. Two days before the visit, the owner reported a behavioral change, circling and obtunded. From the physical examination, all vital signs were normal. Hematological values were within reference interval. However, serum ammonia and pre-prandial post-prandial bile acid were elevated. Thoracic radiographic and abdominal ultrasonographic findings were unremarkable. Computed tomography (CT) result revealed the left gastro-caval shunt with portal hypertension. The cat was diagnosed as feline extrahepatic portosystemic shunt. Surgical excision was applied with cellophane banding. The cat was admitted for post-operative care for 7 days. During the hospitalization, pain assessment was monitored with systolic blood pressure and closely observed the clinical sign of seizure. Moreover, abdominal ultrasonography was performed to monitor ascites and peritonitis. The ammonia and pre-prandial/post-prandial bile acid tests were done on day 1, 7 and 120 after surgery which displayed within normal range. The cat did not express ptyalisim or neurological disorders such as seizure after surgery during the observation period more than 120 days. This case report aimed to describe a successful treatment of portosystemic shunt in a cat.

Keywords: Portosystemic shunts, PSS, Ammonia, Cellophane banding

รายงานสัตว์ป่วย: โรคเส้นเลือดลัดข้ามตับในแมว

ปุณณัตถ์ ดาระกะมาศ[1*] ปัญญกมล จันทรสาขา[1] สุกัญญา มณีอินทร์[2] รุ่งโรจน์ โอสถานนท์[2]
ภาสกร พฤกษะวัน[3] กฤติน ช่วยชู[1] น้ำผึ้ง สื่อมโนธรรม[2]

[1]โรงพยาบาลสัตว์ ประศุอาทร คณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล
ถนนพุทธมณฑลสาย 4 ตำบลศาลายา อำเภอพุทธมณฑล จังหวัดนครปฐม 73170
[2]ภาควิชาเวชศาสตร์คลินิกและการสาธารณสุข คณะสัตวแพทยศาสตร์ มหาวิทยาลัยมหิดล
ถนนพุทธมณฑลสาย 4 ตำบลศาลายา อำเภอพุทธมณฑล จังหวัดนครปฐม 73170
[3]โรงพยาบาลสัตว์แก้วกาญจน์
ถนนบางนา-ตราด ตำบล บางแก้ว อำเภอ บางพลี จังหวัด สมุทรปราการ 10540

[*]ผู้รับผิดชอบบทความ E-mail address: poonnut.dar@mahidol.edu

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บทคัดย่อ

แมวตัวเมีย พันธุ์เปอร์เซีย อายุ 3 ปี น้ำหนัก 4 กิโลกรัม มาพบด้วยปัญหา น้ำลายไหลมากมาเป็นเวลามากกว่าหนึ่งปี และยังพบอาการเดินวน พฤติกรรมเปลี่ยน ตรวจร่างกายลักษณะภายนอกโดยรวมปกติและ ตรวจเลือดเพิ่มเติม พบค่าเลือดโดยรวมปกติ แต่พบค่าแอมโมเนีย ค่าการทำงานถุงน้ำดี มีค่าสูงขึ้นกว่าปกติ หลังจากนั้นจึงได้ทำการการตรวจวินิจฉัยทางรังสีวินิจฉัย ผลการตรวจวินิจฉัย พบว่าแมวป่วยเป็นโรคเส้นเลือดลัดข้ามตับ (Portosystemic shunts) แมวได้รับการรักษาโดยการผ่าตัดโดยใช้เทคนิค cellophane banding หลังจากผ่าตัดแมวพักฟื้นที่โรงพยาบาลสัตว์ประศุอาทร เป็นเวลา 7 วัน มีการควบคุมความเจ็บปวดและติดตามอาการอย่างใกล้ชิด การศึกษาดังกล่าวได้ติดตามอาการของสัตว์ป่วยทั้งสิ้น 120 วัน ได้มีการตรวจระดับแอมโมเนียและค่าการทำงานของถุงน้ำดี ในวันที่ 1, 7 และ 120 ของการศึกษาติดตามอาการ โดยพบค่ากลับมาปกติ นอกจากนั้น แมวไม่แสดงอาการเดินวน อาการทางระบบประสาทอื่นๆ น้ำลายไหลมากกว่าปกติอีกเลย การติดตามทั้งสิ้นใช้เวลาถึง 120 วัน และกรณีศึกษาดังกล่าวนับเป็นความสำเร็จของการผ่าตัดและรักษาแมวเพื่อให้คุณภาพชีวิตแมวดีขึ้นได้นั่นเอง

คำสำคัญ : Portosystemic shunts เส้นเลือดข้ามตับ แอมโมเนีย Cellophane banding

Introduction

Feline portosystemic shunts (PSS) are uncommon vascular abnormalities that cause blood to bypass the liver (Devriendt et al., 2020), resulting in neurological symptoms such as seizures and ptyalism, as well as gastrointestinal and urinary tract signs (Tivers and Lipscomb 2011a). Normally blood drains the stomach and the intestine enters the portal vein, travels through the liver via the hepatic vein, and then to the caudal vena cava but PSS blood from portal vein will bypassing from hepatic (Berent and Tobias 2009). The hepatic function about urea synthesis is also known as the Krebs-Henseleit cycle from intramitochondrial production that change ammonia to urea (Dimski 1994). There are two major types of portosystemic shunts, congenital and acquired. Congenital PSS is commonly seen in small or toy breeds dogs and cats (Hunt et al., 2004b). Young cats may have congenital shunts which can be categorized into extrahepatic and intrahepatic shunts, while acquired PSS usually caused extraheptatic shunt. (Papamichail et al., 2018). An intrahepatic shunt is a vessel that connects the liver to the body (Blaxter et al., 1988). The common breeds with extrahepatic shunt are domestic shorthairs, Persian, British shorthair, Ragdoll, domestic longhair, Birman, British blue and Tonkinese (Lipscomb et al., 2007; Tivers and Lipscomb 2011b). Extrahepatic shunt most frequently located near the kidney caused by hepatic cirrhosis, non-cirrhotic portal hypertension such as hepatic arteriovenous malformation, and hepatic portal venous hypoplasia (Berent and Tobias 2009). In cats, a single extrahepatic vessel entering the caudal vena cava into left gastric vein is the most common form of a congenital portosystemic shunt (Blaxter et al., 1988) .

The type of shunt (intrahepatic or extrahepatic) must be confirmed by using ultrasonography, mesenteric portovenography, computed tomography (CT) or magnetic resonance imaging (MRI) (Tivers and Lipscomb 2011a). Blood examination should be monitored for ammonia, bile acid, coagulopathy, urinalysis, liver enzyme activities, and blood urea nitrogen (Tillson and Winkler 2002a).

Surgery is the treatment of choice for most cats with PSS and medical management is aimed to treat the clinical signs (Valiente et al., 2020). The methods for surgical correction by using extravascular techniques have been reported in cat including ameroid constrictor and cellophane band (Valiente et al., 2020). Ameroid constrictor and cellophane band can cause a tissue reaction in difference ways to slowly attenuate the portosystemic shunt by inducing luminal pressure from thrombosis of the shunt as well as a perivascular reaction which lead to fibrosis (Tobias 2009; Joffe et al., 2019). This procedure focuses on producing a complete shunt decrease causing portal hypertension (Valiente et al., 2020). Postoperative complications in cat after surgical attenuation are common signs of neurological disorders, including seizure (Ruland et al., 2009b). Hypertension and ascites can be found as a resulting of portal hypertension (Buob et al., 2011). This case report aimed to describe a successful for treatments of feline PSS

Case description

A 4 kg, 3 year-old, spayed female, Persian cat had been suffering from depression and ptyalism for the past year. Two days before coming to Prasuarthon Animal Hospital, Faculty of Veterinary Science, Mahidol University, the owner reported a behavioral change, circling and intense depression. This was the first time that the cat visited to animal hospital for illness. The cat was a fully vaccinated and lived indoor with other 11 cats.

On the physical examination of the cat from the first visit, the body condition score was 3/9 and oral cavity was normal with pink mucous membrane. Heart rate, heart sound, respiratory rate and lung sound were normal. Intermittent neurological signs showed dilation of pupils and ataxia. Head shaking, tongue protrusion and muscle tremor were also presented.

Complete blood count (CBC), biochemistry included creatinine, blood urea nitrogen (BUN), liver enzyme, coagulation profile, urinalysis and all other laboratory values were within normal limits (Table 1) excepted serum ammonia and prepradial-postpradial bile acid. Blood ammonia and bile acid concentration was higher than referent range (Table 2), Suspected problem of hepatic function including portosystemic shunt is one of differential diagnosis.

Abdominal radiography showed normal organs in normal position from both ventrodorsal and lateral views. Liver and spleen were unremarkable. Urinary bladder was normal without radiopaque urolith, and normal vertebrae without spondylosis from this radiography (Figure 1). Abdominal ultrasonography revealed that the liver was slightly small with hyperechoic parenchyma, the portal vein and mesenteric vein were dilated and slightly torturous, no any extra hepatic shunts were found. Both kidneys had hyperechoic renal cortex with decreased corticomedullary junction (CMJ) differentiation and mild irregular shape (Figure 2). Abdominal radiography and ultrasonography were unable to rule in PSS. The cat was then generally anesthetized for CT scan of the abdomen with intravenous contrast. The result showed a small size liver with irregular margin. The portal vein was small, a large tortuous shunt vessel arises from the portal vein, courses caudally, to the left cranially past the diaphragm then turning rightward to terminate on the caudal vena cava (CVC), the diameter of this vessel was around 8 mm where it began, the left gastro-caval shunt was suspected with portal hypertension, chronic hepatopathy, splenomegaly (Figure 3). In conclusion, the cat was diagnosed as feline extrahepatic portosystemic shunt.

One month prior to the surgery, the cat was fed with a commercial hepatic diet (Royal canin®, Aimargues, France), for the purpose of reducing blood urea. The cat received 2 milliliter lactulose (Hepalac®, Osoth inter Laboratories CO., LTD., Thailand) two to three times a day to decrease ammonia production approximately one week prior. Hepatic supportive was by milk thistle (Samarin®, Berlin Pharmaceutical Industry CO., LTD., Thailand), and treated with metronidazole 10 mg/kg (Metrolex®, Siam Pharmaceutical Co., Ltd., Thailand). The primary goal is to control anaerobe bacteria population in the intestine and prevent reinfection.

For the surgical procedures, cellophane technique was applied. The advantage for using cellophane is the incident of a life-threatening portal hypertension was very low, however, wider bands or failure to promote shunt closure can develop a multiple acquired shunts. Started with acepromazine 0.04 mg/kg (Combistress®, Kela N.V., Belgium) was used as a premedication, combined with morphine 0.3 mg/kg (M&H Manufacturing Co., LTD, Thailand) intramuscularly administered for analgesia. Anesthetic induction was performed with intravenous alfaxalone 1 mg/kg (Alfaxan®, Accord Intertrade Co., Ltd., Bangkok, Thailand). The patient was endotracheal intubated and maintained the anesthesia with sevoflurance (Baxter Healthcare of Puerto Rico, USA) cefazolin 25 mg/kg (Cafaben®, L.B.S. laboratory LTD., PART., Thailand) and metronidazole 10 mg/kg (Metrolex®, Siam Pharmaceutical Co., Ltd., Thailand) were used as antimicrobial drugs. Inflammation and pain were controlled

by meloxicam 0.2 mg/kg (Metacam®, Labiana Life Sxience, S.A., Barcelona, Spain). The patient was undergone a ventral midline laparotomy. The liver lobes had yellow discoloration. Ventral leaf of the omentum was perforated and the shunt was found on the left side of the caudal vena cava, caudal to the stomach. Turbulent flow was observed within the shunt and 3-folded cellophane band with diameter of 3 mm was placed around the shunt and 4 surgiclips were placed to secure the cellophane. The diameter of shunts was approximately 7.6 mm. and the cellophane can provide the attenuation of the shunt to less than 3 mm. All vital signs including non-invasive measurement of systolic blood pressure were closely monitored. No signs of hepatic congestion and systemic hypertension were observed after placing the cellophane.

After surgery, the cat was hospitalized for 7 days. Pain assessment was counteracted with fentanyl in a constant rate infusion (CRI) monitored by using systolic blood pressure (Table 3). The cat showed no sign of seizure, which can cause by portal hypertension and any relating neurological symptoms such as acute blindness. Daily body weight (Table 3) was measured for monitoring the extravascular fluid leakage and accumulation such as ascites. Moreover, the abdominal ultrasonography was performed during the postoperative period to monitor the correction site of the previous shunt, ascites, peritonitis and hepatic morphology that showed no extrahepatic shunt. In addition, monitoring the location for surgiclips was also observed by using ultrasonography. Nonetheless, the procedure of using the cellophane band can provide a complete shunt closer around 60 ñ 90 days after surgery and the liver function test should be monitored, especially serum bile acid. This case was followed up for 120 days. Therefore, the ammonia test was performed on the first day post operation, 7 days and 120 days respectively (Table 2). Bile acid stimulation test was performed after 120 days (Table 2). After surgical correction, the level of serum ammonia and post bile acid was decrease gradually and was within normal reference range. This cat had no evidence of ptyalism, seizure, or neurological problems, and appeared to be a healthy cat. Hepatic diet was recommended to help in controlling the serum ammonia levels. Ideally, PSS patients should not require a long-term medical management. Lactulose was prescribed to titrate down and stopped for a minimum of 14-28 days, based on clinical signs and severity of the disease. After 48ñ56 days, normal diet may be considered or fed until animal expresses signs of improvement in hepatic function.

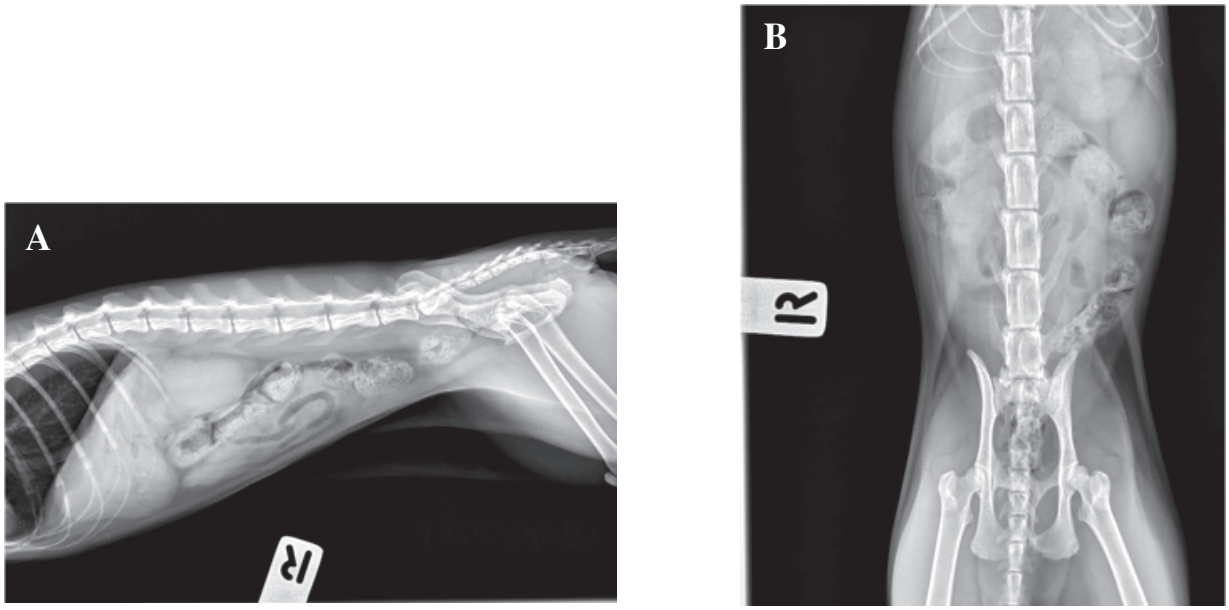

Figure 1. Lateral view (A) and ventro-dorsal (B) of plain abdominal radiograph revealed unremarkable lesion of abdominal organ.

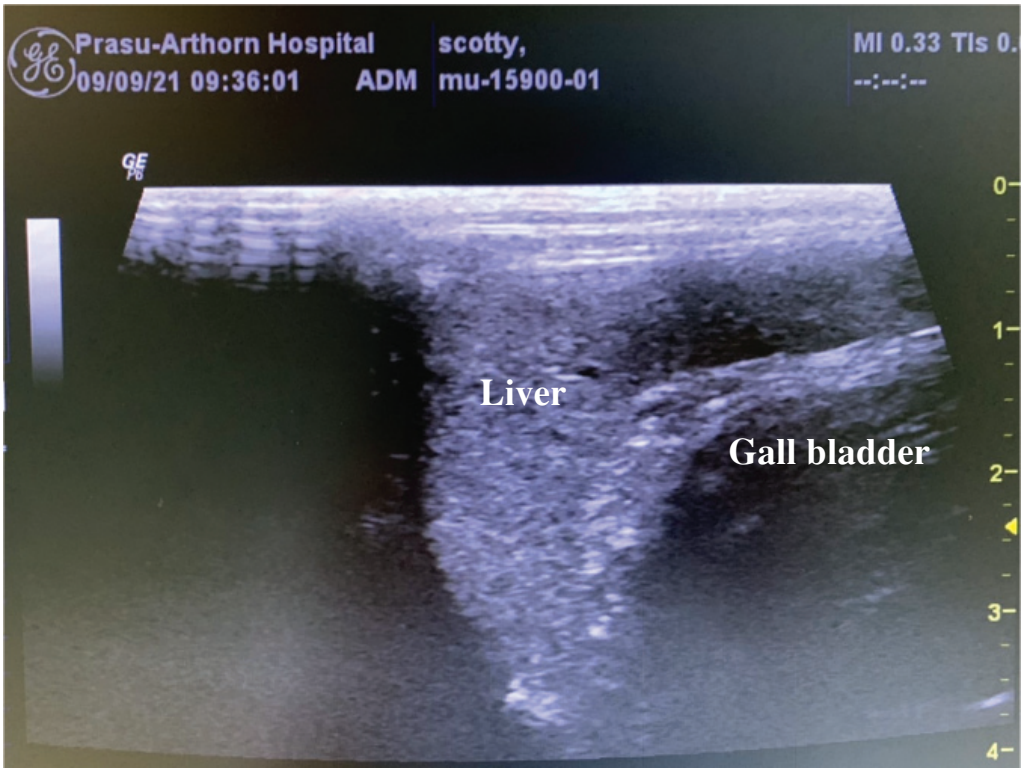

Figure 2. Ultrasonography showed unremarkable lesion of liver and gall bladder.

Figure 3. Left gastric vein reported from computed tomography (CT) angiography image of portosystemic shunt arising from the splenic vein.

Table 1. Hematological report and urinalysis from the first visit.

Parameters	Reference range	Day 0	Parameters	Reference range	Day 0
WBC (u/L)	5.5-19.0	10.44	Coagulation APTT	9.8-19.0	12.3
Monocyte	1-4	4	Coagulation PT	6.5-11.5	9.9
Neutrophil	35-75	72	Coagulation TT	15.1-25.7	18
Lymphocyte	20-55	24	SG	1.010-1.040	1.048
Eosinophil	2-12	0	pH		7.5
Basophil	0	0	LEU		2+
Hct (%)	5.0-10.0	29.2	NIT		-
RBC (106ul)	10-15.0	7.47	PRO		2+
Hb (g/dl)	30-45	10.3	GLU		2+
PLT (103/ul)	300-600	140	KET		-
BUN (mg/dL)	16-36	18	UBG		-
Creatinine (mg/dL)	0.8-2.4	1.14	BIL		-
ALT(U/L)	12-130	94	ERY		-
ALP (U/L)	14-111	50			

**Hct: hematocrit, PLT: platelet, RBC: red blood cell, Hb: hemoglobin, BUN: blood urea nitrogen, ALT: alanine aminotransferase, ALP: alkaline phosphatase, SG: specific gravity

Table 2. Serum ammonia and pre-prandial /post-prandial bile acid report after surgery.

Parameters	Reference range	Day 0	Day 1	Day 7	Day 120
NH3 (umol/L)	0-95	166	33	23	19
Preprandial (umol/L)	0-6.9	6.83	-	-	2.4
Postprandial (umol/L)	0-14	49.67	-	-	2.8

NH_3: ammonia

Table 3. Body weight and systolic blood pressure that show before surgery and postoperative.

Parameters	Day0	Day1	Day2	Day3	Day4	Day5	Day6	Day7
Body weight (kg)	4	4	4	4	4	4	4	4
Systolic blood pressure (mmHg)	170	150	130	130	120	120	120	120

Day 0: before surgery, Day 1-Day 7: after surgery

Discussion

The Persian cat was distinguished and rare case reported as a breed predisposition to many rare diseases such as portosystemic shunts (Lipscomb et al., 2007). This case report, the cat demonstrated a congenital disease since the onset of the disease was starting at a very young age (3-year-old). The portosystemic shunts in cat were initially recognized by clinical signs of hypersalivation, seizure and head pressing, as a result from combination of factors such as hyperammonemia, oxidative stress, inflammation, and false neurotransmitter (Strickland et al., 2021). Hypersalivation has shown in the previous report (Strickland et al., 2021) as well as in this cat.

Laboratory tests are commonly used for diagnosis PSS include serum ammonia and bile acid stimulation test. Fasting ammonia is increase in majority of cats with PSS with 83% sensitivity and 76% specificity, while bile acid stimulation test has 100% sensitivity and specificity 71% (Ruland et al., 2009a). Ammonia is very labile and must be analysed in a short period (Carr 2007). The optimal time for test ammonia is 6 hours (Paepe et al., 2007). Bile acid should be measured in both preprandial-postprandial. Preprandial bile acid will be normal or low in serum, in contrary to postprandial bile acid which stimulated by food will be more than normal range in cat with PSS (Tivers and Lipscomb 2011a). In this report, serum ammonia from the first visit was done before fasting which could cause elevation of ammonia level as a result of the amino acid from dietary proteins producing most of the ammonia (Dimski 1994). However, after fasting the ammonia level was still higher than normal range. Bile acid is important to confirm PSS and the result was abnormal in this case.

Clinical signs should be confirmed with radiographic imaging techniques such as radiography, ultrasonography, and CT scan. First, radiography should not be used as the ultimate diagnosis or rule out PSS. Moreover, it cannot distinguish between acquired portosystemic shunts or congenital portosystemic shunts (Blaxter et al., 1988). Identification of portosystemic shunt

by ultrasonography can be difficult due to the present of gas in gastrointestinal tract, urolithiasis, and renomegaly could curtail the portosystemic shunts (Lamb et al., 1996). Nonetheless, the ultrasonography could reveal microhepatica with normal echogenicity. The ultrasonography was one clue technique to aid in diagnosis the porta hepatic (Leeman et al., 2013). However, it was unable to make a definitive diagnosis the PSS in this report. (Papamichail et al., 2018). Limitation was it required the specialist who experienced in using color and pulse Doppler (Lamb 1998). CT scan measurement has higher sensitivity and specificity than ultrasonography especially in cat. CT scan reported vessels of PSS in cat are gastroduodenal vein, a colonic vein, azygous vein (Blaxter et al., 1988; Cabassu et al., 2011). In this case report, left gastric vein was found and was considered as the most common type of extrahepatic portosystemic shunts similarly to the previous reports in Persian cat (Lipscomb et al., 2007).

There were two surgical procedures that could be performed in this case by using the ameroid constrictor and cellophane band. Ameroid constrictor in cat has a poor outcome and should be cautious after use (Lipscomb et al., 2007). Considering ameroid constrictor made from casein and stainless steel which encases a C shaped doughnut of casein, Casein will absorbs body fluid the ameroid ring constrictor to close to 42-48% and possibly induces risk of allowing continued shunting (Hunt et al., 2014). Furthermore, the ring is scrutinizing as a metal artifact which has a reaction with CT scan (Leeman et al., 2013). Cellophane, made from cellulose (McAlinden et al., 2010), does not effect with the CT imaging and have no tissue reaction from antibody. Survival rate was presented around 33-75 % (Valiente et al., 2020), but cellophane band is more effective method of alleviating hepatic dysfunction resulting from a congenital portosystemic shunt. Incident of life threatening portal hypertension was very low when using a cellophane band (Havig and Tobias 2002) and survival rate are reported as 66-100% (Valiente et al., 2020) the same as in this case report. Mostly in dog, another surgical option is vessel ligation but the prognosis is based on the degree of shunting and was considered out of date (Tillson and Winkler 2002b; Hunt et al., 2004a). Nevertheless, in cats survival rate ranged from 66-75% for this method (Valiente et al., 2020).

Duration of hospitalization was 7 days after surgery for close monitoring. Cats can develop refractory seizure (Cabassu et al., 2011). However, it was not found in this case. Postoperative seizure can be minimized with preoperative levetriracetam as a prevention Nonetheless, it did not prevent the occurrence of a further seizure. It was suggested that the dosage for levetrracetam is 20mg/kg every 6 hour during 24 hours preoperative period and continue for 5 days postoperation (Strickland et al., 2021). Some cats were euthanized after surgery in 90 days because of the uncontrolled seizure (Valiente et al., 2020). This case report has monitored the cat for more than 120 days and no seizure was observed. Ideally, a close monitor of shunt by a CT scan is very useful (Leeman et al., 2013) but limited in this case due to a financial issue. The authors decided to monitor with ultrasonography after surgery. Neurological signs were the only fatal postoperative concern which developing in 37% of cats (Lipscomb et al., 2007) within 3 days post operation. Other factors that also imperative are serum glucose, electrolyte and bile acid level (Greenhalgh et al., 2010).

Another disease with a similar clinical sign was a primary hypoplasia of portal vein but very rare in cats. The typical screening test was blood examination especially

ammonia and bile acid. For the histolopathology from liver biopsy can be used to confirm the acquired portosystemic shunts with the decreased of portal vein diameter or absence of the portal vein, number of arteriolar profiles are more than normal (Sugimoto et al., 2018). However, liver biopsy was not done in this case report because of that invasive diagnosis. Later hepatic disease in this study was rule out by relative noninvasive such as hematology and liver laboratory test. In dog, liver histopathology from liver biopsy led to detection of hepatic lipogranulomas (Isobe et al., 2008).

Conclusion

In this report, congenital portosystemic shunts in cats can be diagnosed not only by ultrasonography but also by CT scan. A serum ammonia levels is required as well as serum bile acid test. Thus, cellophane band of surgery is an ideal way for surgical procedure that supporting the previous reports. Seizures can be occurred before, during, or after surgery, and is mostly the cause of mortality. The owner's dedication is supporting the diagnosis, surgery, and postoperative care of PSS. The major limitation in this case was lacked of hepatic histopathology and limited postoperative gold standard CT scan to confirm shunt closure.

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