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CASE REPORT
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Abordagem transcirúrgica e acompanhamento pós-operatório de um canino com um shunt esplênico-azigos

Transurgical Approach and Postoperative Follow-Up of a Canine with a Splenic-Azygos Shunt

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ABSTRACT

***Background*:** The most frequent hepatic circulatory abnormality in dogs is the portosystemic shunt, characterized by an atypical deviation of the hepatic blood flow, that causes the blood that should be drained by the liver through the portal vein to be diverted to another systemic vein, as a result of the presence of the anomalous vessel. This diversion leads to reduced hepatic blood flow and, consequently, organ dysfunction, along with the accumulation of many toxins in the circulation, for instance, ammonia and short-chain fatty acids. The main objective of this paper is to Report the clinical case of a canine female diagnosed with an extrahepatic portosystemic shunt and submitted to surgical treatment using an ameroid constrictor ring in the obstruction of the anomalous vessel.
***Case*:** A canine Shih-Tzu, at the age of 1 year and 8 months, was brought to the Veterinary Hospital presenting a history of emesis and smaller body structure than other animals from the same litter. The animal had been diagnosed with portosystemic shunt at age 1 month, by means of complementary biochemistry, ultrasonography and computed tomography examinations. The latter identified the anomalous vessel, which originated from the left gastric vein and was inserted into the azygos vein in the portohepatic region. During the surgical intervention, after median pre-retro-umbilical celiotomy, a calibrous vessel was identified, coming out of the junction of two splenic veins and a gastric vein that penetrated the diaphragm and connected to the azygos vein in the thorax before flowing into the vena cava. Given that, the diaphragm had to be sectioned, which lead to the loss of the negative intra-thoracic pressure, requiring muscle suturing to restore it. A small dissection was performed around the vessel for the ameroid constrictor placement. There was no complication during the procedure. Ten days after the surgery, the clinical evaluation and new blood tests showed that the patient was active, did not express pain and was fully recovered. Ten days after the first follow-up visit, the owners mentioned that the patient was reluctant to eat the prescribed diet, though she was clinically well and her blood test results were within normal ranges for the species. The animal did not have any episodes of apathy, anorexia or vomiting, gained weight (4.2 kg) and the clinical evolution was confirmed by the normality of the blood tests at the subsequent postoperative return visits (60, 180 and 356 days after the surgery). A year after the intervention, imaging exams were repeated and showed normal direction and velocity of the portal flow for the entire extra- and intrahepatic portal extension, liver growth with dimensions compatible with the species, and no blood flow in the anomalous vessel, as well as the presence of a radiopaque structure in the left epigastric region.
***Discussion*:** Regarding the choice of anesthetic protocols for these patients, attention had to be paid to the choice of drugs since the liver was already compromised and most drugs are metabolized in the liver. When it comes to the surgical procedure, the most common surgical complication would be portal hypertension, which occurs when total ligation of the anomalous vessel is performed. Although the surgical treatment is extremely challenging, the obstruction of abnormal blood flow of an anomalous vessel achieved by surgical placement of an ameroid ring was able to correct the hemodynamic changes presented by the patient, and to reverse the hepatic insufficiency and the increase in the size of the liver.

Keywords: dog, canine, surgery, hepatic, insufficiency.

Descritores: cachorro, canino, cirurgia, hepática, insuficiência.

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INTRODUCTION

The portosystemic shunt is the most common hepatic circulatory abnormality in dogs, characterized by an abnormal deviation of the hepatic blood flow, that causes the blood that should be drained by the liver through the portal vein to be diverted to another systemic vein, due to the presence of the anomalous vessel. This deviation results in reduced hepatic blood flow and subsequent organ dysfunction [4,7], as well as the accumulation of many toxins in the circulation, such as ammonia and short-chain fatty acids. The shunt can be classified as intra or extrahepatic.

The definitive diagnosis for this disease should be a summation, of the medical history, physical examination, complementary examinations such as ultrasonography (US), per-rectal portal scintigraphy, tomography, and/or exploratory laparotomy. The US test is a non-invasive method that is able to detect the blood flow deviation. However, a normal examination does not rule out the occurrence of a shunt [13].

The aim of the treatment for PDS is to cause the blood to flow back through the liver. The definitive treatment is surgical, correcting the vascular abnormality by means of ligation or implantation of a metal ring [5,7,8,10].

The objective of this article is to report the case of a patient with an extrahepatic portosystemic shunt, who underwent surgical treatment for correction of abnormal blood flow by obstructing the anomalous vessel with an ameroid constrictor. It presents the anesthetic and transurgical approaches and the postoperative follow-up for the period of one year, and demonstrates the evolution of the patient and the reestablishment of normality of the clinical signs during this period.

CASE

We report the case of a female canine, Shih Tzu, 1 year and 8 months of age and weighing 3.9 kg, with a history of daily vomiting and with smaller bodily structure and size than the other animals from the same litter. The animal was attended at the Veterinary Hospital, previously diagnosed at age 1 month with a portosystemic shunt by means of complementary biochemistry, ultrasonography, and computed tomography examinations.

The biochemical test showed all liver enzymes to be elevated, as shown in Table 1 (Time 1). The ultrasonography examination showed the liver with defined contours, regular margins, and reduced size, and both kidneys with increased echogenicity of the cortex and pelvis and the presence of calculi in the bladder. In the vascular ultrasonography, a diminished diameter of the portohepatic segment of the portal vein with hepatofugal flow was observed, and a tortuous calibrous vessel (0.62 cm) with apparent origin in the splenic vein and insertion in the azygos vein, characterizing an extrahepatic portosystemic deviation and suggesting a splenic-azygos shunt.

Based on the above-mentioned findings, computed tomography was performed and identified the anomalous vessel that originated in the left gastric vein and was inserted into the azygos vein in the portohepatic region. The examination revealed the vena cava with a diameter of 0.80 cm and the portal vein with a diameter of 0.41 cm.

At the Veterinary Hospital, on the day of the first medical consultation, new blood tests were performed, as shown in Table 1 (Time 2).

On the day of the surgery, 30 days following the first visit, a new evaluation was made. A physical examination showed the animal to be normohydrated, with normocolored mucosa, capillary refill time (CRT) equal to 2 seconds and a strong pulse. Blood tests, as seen in Table 1 (Time 3) and arterial gasometry (i-STAT CARTRIDGE EG7+®)[1] showed a pH of 7.29, partial carbon dioxide pressure ($PaCO_2$) of 38.1 mmHg, bicarbonate (HCO_3-) of 18.7 mmol/L, oxygen saturation (SpO_2) at 81%, sodium (Na^+) of 149 mmol/L, and potassium (K^-) of 3.7 mmol/L. The patient's cephalic vein was catheterized with a 22G catheter, simple Ringer's solution[2] fluid therapy was started at a velocity of 10 mL/kg/h, and an extensive trichotomy of the abdominal region was performed.

As preanesthetic medication, an infusion of remifentanil[3] (Remifentanil Hydrochloride 2 mg - 0.3 µg/kg/min) was administered. After 15 min of the infusion, anesthesia was induced with propofol[3] (Propovan® - 4 mg/kg) and the patient was intubated. Anesthetic maintenance was performed with isoflurane dissolved in 100% medicinal oxygen in a Baraka open circuit, without reinhalation. Also, for transurgical analgesic control, the remifentanil[3] (Remifentanil Hydrochloride 2 mg - infusion 0.3-0.5 µg/kg/min) was maintained until the end of the procedure. Subsequently, the right dorsal pedis artery was catheterized in order to measure arterial pressure invasively by means of a multiparametric monitor. The patient was monitored using pulse oximetry, electrocardiography, and capnography.

A median pre-retro-umbilical celiotomy of approximately 10 cm was performed, allowing the exploration of the organs of the abdominal cavity. The portal vein and vena cava were identified, and their diameters found to be compatible with the description from the vascular ultrasonography. A tortuous and calibrous vessel was identified originating at the junction of two splenic veins (Figure 1) and a gastric vein that penetrated the diaphragm and connected to the azygos vein in the thorax before flowing into the vena cava. In response to this finding, the diaphragm was sectioned, and the negative intra-thoracic pressure was lost, making it necessary to subsequently restore pressure and suture the muscle.

The anomalous vessel had an approximate diameter of 0.6 cm and a small dissection was performed around the vessel close to its origin for the placement of the ameroid constrictor[4]. A suture was performed around the constrictor to prevent its displacement along the vessel. The celiotomy was sutured at three levels: the muscle wall sutured with absorbable synthetic thread (Polyglactin 910)[5] and Sultan stitches; the subcutaneous tissue with absorbable synthetic thread (Polyglactin 910)[5] and simple continuous stitches and skin with non-absorbable synthetic thread (Black monofilament nylon needled yarn)[6] and Wolff-type stitches. No surgical complication was encountered during the procedure.

The procedure lasted 150 min. From the monitoring of the anesthesia, it was observed that the animal had SpO_2 between 97 and 100%, with O_2 flow at 10 mL/kg/minute. The end-tidal carbon dioxide ($ETCO_2$) was maintained between 25 and 60 mmH_20 throughout the anesthesia.

The heart rate was maintained at between 85 and 180 beats per minute (bpm). The animal's mean arterial pressure was normal (MAP > 60 mmHg) for the first 90 min and then began to decline (MBP 55 mmHg). As soon as hypotension was detected, a continuous dopamine[7] (Dopamine Hydrochloride 5 mg/mL - infusion 10-15 µg/kg/min) was initiated and maintained up until 110 min of anesthesia.

The dog demonstrated a great deal of abdominal pain and vocalization when coming out of anesthesia and it was decided to keep the patient on a remifentanil[3] (Remifentanil Hydrochloride 2 mg - infusion 0.3 µg/kg/min for 12 h). At the end of the infusion, the dog appeared to be well, without pain, and analgesia continued to be administered with morphine.

During the hospitalization period (eight days), glycaemia, blood pressure, temperature, heart rate, respiratory rate, and response to painful stimuli from abdominal palpation were monitored daily. Metronidazole[3] (Metronizadole 5 mg/mL - 15.0 mg/kg, twice a day, 7 days), ceftriaxone[8] (Amplospec® 1 g - 30.0 mg/kg, twice a day, 8 days), meloxicam[9] (Elo-xicam® 0,2% - 0.1 mg/kg, once a day, 4 days), and morphine[10] (Morphine Sulfate 10 mg/mL - 0.5 mg/kg, every 4 h, 3 days) were administered.

On the second day, there was a drop-in glycaemia (mean value of 60 mg/dL) and glucose solution fluid therapy was instituted. However, the glycaemia remained low and 3.0 mL of an industrialized product rich in glucose was administered orally, restoring the physiological values for the species, which were maintained throughout the day. The glucose solution was maintained until the 5th day of hospitalization.

On the second day, a decrease in systolic arterial pressure (SAP = 100 mmHg, decreased SAP = 80 mmHg) was observed and a colloid fluid bolus[3] [Voluven® 6% 10.0 mL/kg was administered, repeated 8 h later (5.0 mL/kg)], reestablishing the pressure to normal values. The hemogram was repeated, showing leukocytosis, Table 1 (Time 4). On the fourth day, the morphine[10] (Morfine Sulfate 10 mg/mL) was replaced by tramadol chlorhydrate[11] (4.0 mg/kg, three times a day, 4 days).

Ten days following surgery the blood tests were repeated (Table 1, Time 5) and the clinical evaluation showed the patient to be active, without pain, and fully recovered. The radiographic and abdominal vascular ultrasound examinations were repeated and showed the presence of the metal ring in the left epigastric region (Figure 2), favorable evolution of the characteristics of portal vascular flow, with normal hepatoportal direction and velocity throughout the extra- and intrahepatic extension, a slight enlargement of the liver, and reduced blood flow in the anomalous vessel.

The patient was discharged at ten days following surgery with a prescription of adenosylmethionine (SAME 150.0 mg)[12], 1 capsule, orally, once a day; silymarin[12] (39.0 mg, 1 capsule, orally, three times a day); and a diet based on commercial low-protein kibble and cottage cheese.

At the 20-day postoperative follow-up visit, the dog was clinically well, the blood test results within normal ranges for the species, but the owners reported that it was reluctant to eat the prescribed food, so an adjusted diet of rice, cooked potato, cooked squash, and meat was suggested.

At the subsequent 60-, 180-, and 365-day postoperative return visits, the clinical evolution of the patient was confirmed by the normality of the blood tests and weight gain (4.2 kg) and no episodes of apathy, anorexia, or vomiting. The imaging examinations were repeated a year after the procedure and revealed portal flow exhibiting normal direction and velocity for the entire extra- and intrahepatic portal extension, an increase in liver measurements with dimensions compatible with the species, and the absence of blood flow in the anomalous vessel, as well as the presence of a radiopaque structure in the left epigastric region.

DISCUSSION

Congenital portosystemic deviations (PSD) are usually diagnosed in animals under one year of age with symptoms related to the central nervous system and the gastrointestinal and urinary tracts, but age group alone does not serve to differentiate acquired from congenital shunts [13]. Hemodynamic changes were observed in the case described, in which the patient was older than one year of age and presented both urinary tract and gastrointestinal tract signs.

Generally, affected animals present small body structure, an inability to grow, or weight loss [4]. This liver dysfunction also may present non-specific signs such as anorexia, polyphagia, vomiting, intermittent diarrhea, and hepatic encephalopathy [5,9]. This animal was the smallest of the litter and also presented a history of recurrent vomiting.

Taking breed epidemiology into account, the breeds most affected by this condition are miniature Schnauzers, Yorkshire Terriers, Poodles, Maltese, Shih Tzus, and Dachshunds [4], as in the reported case, in which the patient was a Shih Tzu and with a history of consanguinity.

In a portosystemic shunt, decreased liver size, as exhibited in the initial imaging exams, is a direct consequence of reduced blood flow, decreasing the ability of the liver to metabolize the intestinal toxins that accumulate in the blood [3,13]. The kidneys and bladder should also be examined, in the search for

Table 1. Table showing values from hemogram, leukogram, and serum biochemistry performed at different times during the monitoring of a patient submitted to surgical correction of an extrahepatic portosystemic shunt using an ameroid ring.

Type of exam	Variables	Values observed				
		Time 1 (Before treatment at the VH-UVV)	Time 2 (First treatment at the VH-UVV)	Time 3 (Day of surgery - 30 days after Time 2)	Time 4 (2 days following surgery)	Time 5 (10 days after surgery)
Hemogram/ Leukogram	Erythrocytes	9.75 million/µL	7.65 million/µL	8.5 million/µL	7.62 million/µL	5.70 million/µL
	Hematocrit	46.0%	39.3%	43.7%	39.3%	32.4%
	MCV	47.2 fl	51.5fl	51.1fl	51.6 fl	57.0 fl
	MCHC	32.6 %	34.6%	32.2%	33.0%	32.4%
	Protein	7.2 g/dL	5.6 g/dL	6.0 g/dL	4.0 g/dL	6.0 g/dL
	Leukocytes	8.800/µL	18.800/µL	19.000/µL	26.900/µL	23.600/µL
	Bands	0%	1%	0%	2%	0%
	Segmented	49%	73%	74%	80%	77%
	Lymphocytes	47%	22%	15%	14%	18%
	Platelets	132 mil/µL	301mil/µL	371 mil/µL	269 mil/µL	376 mil/µL
Biochemistry	ALT	181.2 UI/L	131 UI/L	96.0 UI/L	-	158.9 UI/L
	Creatinine	0.52 mg/dL	0.6 mg/dL	0.6 mg/dL	-	0.7 mg/dL
	Urea	17.8 mg/dL	11.6 mg/dL	21.7 mg/dL	-	19.2 mg/dL
	AST	67.6 UI/L	-	66.3 UI/L	-	-
	AP	234.0 UI/L	113 UI/L	110.3 UI/L	-	209.5 UI/L
	GGT	18.9 U/L	-	8.8 UI/L	-	-
	Total protein	5.93 g/dL	5.1 g/dL	6.0 g/dL	-	-

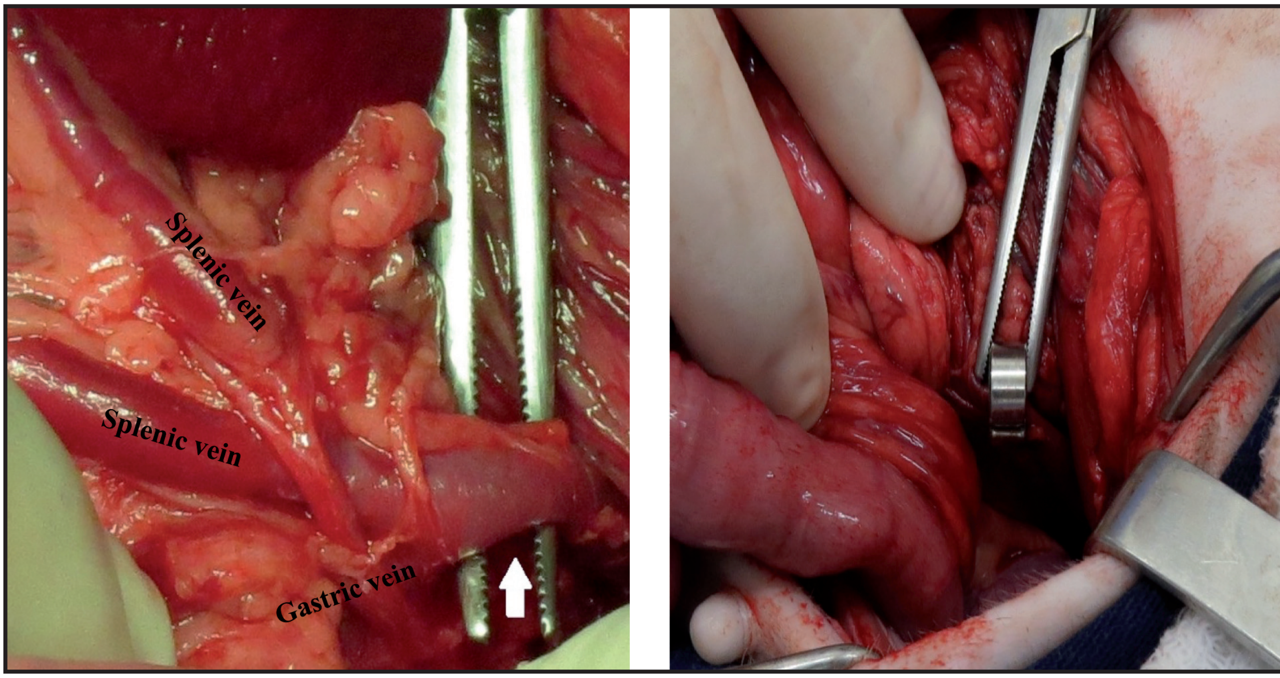

Figure 1. Anatomical aspect of the anomalous vessel of approximately 0.6 cm in diameter, viewed during the surgery (arrow), coming from two splenic veins and one gastric vein (A). Positioning of the metal ameroid constrictor in the proximal portion of the anomalous vessel (B).

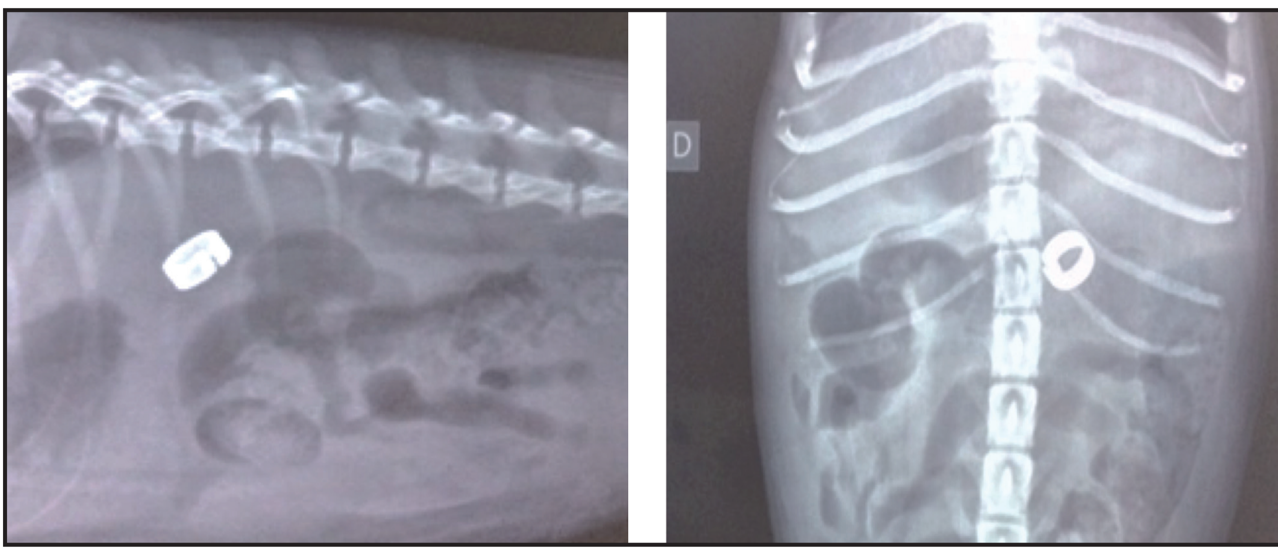

Figure 2. Radiographic exam performed 10 days following surgery of a patient treated surgically to obstruct the anomalous vessel using an ameroid constrictor. A- Lateral projection of the abdominal region showing a radiopaque structure in the form of a ring, located below the twelfth thoracic vertebra proximal to the stomach. B- Ventro-dorsal projection of the abdominal region showing a radiopaque structure in the form of a ring located in the left epigastrium next to the twelfth thoracic vertebra (D = right).

urate urolithiasis, as in the reported case where bladder calculus was found. In most cases, the bladder calculus found were due to the accumulation of ammonia in the blood, which is filtered by the kidneys, resulting in the calculi observed [3,7]. The liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and alkaline phosphatase (FA) may be normal to slightly elevated, as in the case described [4].

Dogs with congenital portosystemic shunts tend to have hypoglycemia caused by glycogen insufficiency due to the inadequate capacity of the liver to store glucose, to abnormal insulin metabolism, and to surgery and anesthesia-induced stress [4,7]. Associated with these conditions, the patient also presented hypoglycemic peaks during hospitalization due to low food intake, despite the dietary prescription.

Extrahepatic shunts can originate from the portal vein, left gastric vein, or splenic vein, directing the flow to the caudal vena cava, azygos vein, or other systemic veins without passing through the liver [7]. In this case report, it was an extrahepatic shunt that originated from two splenic veins and one gastric vein in the direction of the diaphragm, and met up with the azygos vein in the thoracic region.

Regarding the choice of anesthetic protocols for these patients, attention must be paid to the choice of drugs since the liver is already compromised and most drugs are metabolized in the liver [6,11]. The choice of remifentanil, a μ-receptor agonist opioid of ultra-short duration (approximately 5 min), as the preanesthetic medication and transoperative analgesic, was due to high solubility and potent analgesia. It was used in continuous infusion, mainly due to its pharmacokinetics [1,11]. Its composition includes a methyl ester side chain that allows metabolism by non-specific blood and tissue esterases (carboxylesterase), without hepatic metabolism, as with fentanil. Its duration is very short, a result of extensive extrahepatic metabolism, unlike other opioids that depend on redistribution to the tissues to terminate the effect and hepatic metabolism for excretion. Remifentanil is a powerful respiratory depressant and if used during anesthesia, mechanical ventilation may be required [1]. Opioids markedly lower the concentration of volatile anesthetic agents, reducing the collateral effects caused by them [2,11]. Recovery from this drug is rapid, even after prolonged infusion, since its plasmatic concentration is reduced by 50% after 3 to 10 min, regardless of the infusion time [11]. However, its rapid metabolism can result in a decline in analgesia during recovery [2,11].

Propofol, an intravenous general anesthetic that is redistributed and metabolized extremely rapidly, was used for induction. Propofol causes a loss of consciousness within 20 to 40 s when administered via IV and its clearance exceeds hepatic blood flow, indicating that other locations, in addition to the liver, participate in its excretion [2,11].

As regards the surgical procedure, the most common surgical complication is portal hypertension, which occurs when total ligation of the anomalous vessel is performed [5,9]. This occurs because the hepatic vessels are not yet able to withstand the large blood flow that, suddenly, begins to pass through the liver. In order to prevent this hemodynamic complication, it is important that the occlusion of the vessel be gradual, no matter which technique is chosen. For this reason, cellophane and suture threads were not used during the corrective procedure to prevent the radical obstruction of the vessel [5,8,10], opting instead for the metal constrictor.

It is known that the ameroid ring, chosen as the biomaterial to accomplish the obstruction of the anomalous flow during the procedure, can absorb liquids slowly, causing the internal part of the ring to increase in volume, reducing the central diameter, and gradually constricting the vessel due to the expansion of the ameroid substance. Occlusion occurs as fibrosis develops around the vessel and, although several factors can alter the closing velocity, the fastest expansion normally occurs between the 3rd and the 14th day after implantation [8,10]. Corroborating the statements of the authors, a significant decrease in the blood flow of the anomalous vessel and favorable evolution of the characteristics of the portal vascular flow were observed in the vascular ultrasound examination performed ten days after surgery.

The biggest challenge during the surgical procedure was identifying the anomalous vessel, even with prior anatomical knowledge and the help of transsurgical ultrasonography, since anatomical references, such as the portal vein, the vena cava, and the abdominal organs, such as the liver, were altered. In addition, the anatomical surgical aspect is not always compatible with the description in the reports, which creates insecurity at the moment of ligation. Difficulty identifying the anomalous vessels was not reported by any author during the biographical research conducted, however, even with a trained surgical team and with prior anatomical knowledge, it is inferred that said difficulty is common to all the procedures, though not reported.

Parker *et al*. [12] accompanied 64 dogs following surgery to correct portosystemic shunts, both intra- and extrahepatic. They reported average survival of 51 months for patients with extrahepatic and 30 months for those with intrahepatic shunts. However, the morbidity and mortality rates observed were high (approximately 50%), with 6% dying in the immediate postoperative period, 17% dying by the tenth day, and 25% by the eighth month of follow-up. The evolution of the patient reported was satisfactory during the 12 months of follow-up, with a notable gain in body weight, normal blood and biochemistry exams, and visualization of the normal direction and velocity of the portal vein flow and absence of blood flow in the anomalous vessel. Although the surgical treatment is extremely challenging, obstruction of abnormal blood flow of an anomalous vessel achieved by surgical placement of an ameroid ring was able to correct the hemodynamic changes presented by the patient, and to reverse the hepatic insufficiency and the increase in the size of the liver. During patient follow-up, we confirmed weight gain, the absence of episodes of vomiting, and normal laboratory blood test values, all of which are variables that reinforce the success of the treatment performed.

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