Successful diagnosis and treatment of a pelvic limb arteriovenous fistula in a cat

M. VAGNEY¹, C. PONCET¹, E. LE MASNE², J. HERNANDEZ*²

¹Centre Hospitalier Vétérinaire Frégis, 43 avenue Aristide Briand, 94110 Arceuil, France
²Service d'imagerie fonctionnelle, Hôpital Pitié-Salpêtrière, 75013 Paris, France
³Dr J. Hernandez, Internal Medicine Unit of Oniris, Nantes-Atlantic College of Veterinary Medicine and Food Sciences, Atlantele La Chantrerie, CS 40706, 44307 Nantes Cedex 3, France.

Summary
Peripheral arteriovenous fistulas (AVF) are vascular anomalies that have rarely been reported in veterinary medicine. The present case documents specific clinical, diagnostic, and therapeutic features of the disease. A 6-year-old male neutered outdoor domestic shorthair cat presented with a 16-month history of intermittent swelling and lameness of his left pelvic limb. Examination of the left inner thigh revealed a tortuous dilatation of the saphenous vein. Blood flow was assessed using an acoustic Doppler instrument. Examination of the proximal inner thigh with the probe placed on the femoral artery and vein region revealed pulsatile and continuous blood flows. When the probe was moved distally following the femoral vein to the medial saphenous vein upon further examination, the signal of the continuous blood flow changed to both a continuous and pulsatile ‘machine-like’ sound. This acoustic Doppler pattern was suggestive of an arteriovenous communication. An arterialized waveform and dilatation in the draining vein were seen by color echo-Doppler examination, thus providing further indication of an arteriovenous fistula. Surgical excision of the AVF was successful, thereby allowing for long-term remission. The use of continuous wave acoustic Doppler examination in veterinary medicine has not been described previously. In the present case, continuous wave acoustic Doppler examination was suggestive of an arteriovenous fistula, and further examination by color echo-Doppler provided further support for this diagnosis. Data evaluating physiological peripheral blood flows are however lacking in veterinary medicine, and further studies are warranted.

Keywords: arteriovenous; fistula; pelvic limb; Doppler; surgery

Introduction
Arteriovenous fistula (AVF) is a vascular anomaly consisting of a communication between an artery and a vein. This defect can be either congenital or acquired (e.g. secondary to trauma, neoplasia, infectious or inflammatory processes, or iatrogenic). Clinical signs, as well as the type and intensity depend on the location of the site (e.g. the liver, a limb) and their impact on the cardio-vascular system. Investigation of such lesions often requires resorting to diagnostic imaging [5, 22, 29]. This article presents clinical, diagnostic, and therapeutic features of a peripheral arteriovenous fistula, as these have so far only rarely been reported in veterinary medicine [1-2, 4, 6, 7, 10, 12-13, 17, 21-28, 30].

Observation
A 6-year-old male neutered outdoor domestic shorthair cat was referred for further investigation of a 16-month history of intermittent swelling and lameness of his left pelvic limb. Clinical signs had been intermittent and unresponsive to the antimicrobial and corticosteroid treatments previously recommended by the referring veterinarian.

On physical examination, there was swelling and pitting oedema of his left pelvic limb (Figure 1), and the interdigital skin of his paw was moist due to leakage of oedematous fluid. Scars, consistent with bite wounds, were present on the proximal portion of the affected limb. It felt neither hot nor cold on palpation. Examination of the inner thigh revealed a tortuous dilatation of the saphenous vein (Figure 2). No palpable thrill or Nicoladoni-Braham sign was found, and the femoral pulse was present. No further systemic abnormalities were noted, vitals parameters including rectal temperature were within normal limits and the cat was otherwise in good body condition.
In the light of these findings, differential diagnosis included vascular events (venous thrombosis, embolism), inflammatory diseases (infectious or immune-mediated vasculitis or lymphangitis), vascular anomaly (AVF, venous aneurysm), neoplastic diseases (hemangioma, hemangiosarcoma, angiosarcoma, lymphangioma, …) or less likely proximal extraluminal vascular obstruction (abscess, granuloma, benign or malign neoplasia). Idiopathic lymphoedema was also considered. Complete haematology and serum biochemistry profiles were within the normal laboratory range. Blood flow was firstly assessed using an 8 MHz continuous wave acoustic Doppler instrument (Vet BP Doppler, Mano Médical, France). Examination of the proximal inner thigh with the probe placed in the femoral artery region revealed an arterial pulsatile blood flow. With the probe placed in the femoral vein region, a venous continuous blood flow could be heard. When moving the probe distally while following the femoral vein to the medial saphenous vein, the signal representing venous continuous blood flow changed to a continuous ‘machine-like’ sound, similar to what is usually heard while auscultating patients with left to right patent ductus arteriosus. The maximal intensity of the ‘machine-like’ sound was found in the area of the maximal venous dilatation. This continuous wave acoustic Doppler pattern was suggestive of an arteriovenous communication. The assessment was then pursued by echo-Doppler examination using a Philips CX50 ultrasound machine (Philips Ultrasound, Andover, MA, USA) equipped with a 7.0-15.0 MHz linear probe. This revealed an enlarged diameter of the cranial rami of the medial saphenous vein (3.5 mm) compared to the diameter of the cranial branch of the saphenous artery (0.6 mm). Color Doppler examination of the cranial rami of the medial saphenous vein revealed a turbulent flow. Pulsed spectral Doppler investigation revealed a systolo-diastolic flow with a pulsatile component. This arterialized waveform and dilatation in the draining vein were also suggestive of an AVF that was suspected to be between the cranial branch of the saphenous artery and the cranial rami of the medial saphenous vein (Figure 3). Computed tomography with intravenous contrast injection was indicated to confirm the latter suspicion, with a view to rule out the presence of underlying process (neoplasia in particular), and to provide a pre-treatment vascular mapping of the region. The latter was declined because of financial constraints. Surgical investigation was then decided considering the high suspicion of a defective vasculature and previous unsuccessful medical management. The cat was premedicated with opioid analgesia (methadone, Comfortan®, 0.2 mg/kg IV) and anesthesia was induced with propofol (2.8 mg/kg IV) and maintained with isoflurane. Prophylactic antibiotic (ceftiofur, Excenel®, 2.2 mg/kg IV) was administrated. The left pelvic limb was clipped and surgically prepared; a curvilinear skin incision was made on the inner side of the distal third of the tibia, laterally to the tortuous dilatation of the saphenous vein. After subcutaneous tissue dissection, the connection between the cranial branch of the saphenous artery and the cranial rami of the medial saphenous vein was confirmed (Figures 4 and 5). A smooth and delicate dissection of tissue was performed with a right angle forceps in order to isolate the vessels and
the fistula. Resection of the AVF was performed by occluding the cranial branch of the saphenous artery with hemostatic vascular clips (Teleflex®) while preserving the remainder of the vasculature. The diameter of the medial saphenous vein decreased immediately intraoperatively (Figure 6). The wound was closed using routine procedures, and the cat recovered uneventfully from the anesthesia.

Histopathological examination revealed numerous closely packed and variably-sized vessels with irregular lumens. Their walls exhibited disorganized layers, separation of muscular fibers by marked fibrosis, and an absence of elastic fibers. There was no sign of inflammation. Overall, these findings were consistent with a traumatic arteriovenous fistula. No signs of neoplasia, vasculitis or connective tissue disorder were reported.

In the three days following the surgery, the cat did not have any signs of lameness or pain while manipulating the left pelvic limb. The edema improved considerably. The paw felt warm to the touch, and each digit exhibited superficial sensation. The cat was discharged from the hospital with continued administration of anti-inflammatory doses of oral corticosteroids (i.e. Prednisolone, Dermipred®; Sogeval; 0.5mg/kg q24h) for a further 10 days. Two days following discharge, there was still slight swelling proximally, but the size of the left limb became similar to that of the right limb two weeks later (Figure 7). The cat was deemed to be clinically normal at the 15 month post-surgery follow-up.

Discussion

Peripheral AVFs are vascular anomalies that have rarely been reported in veterinary medicine [1-2, 7, 9-10, 12, 17, 21-28, 30-31]. A review of the feline veterinary literature indicates that only three hepatic [16, 19] and seven peripheral AVFs have been reported to date [7, 10, 17, 23, 26, 28]. No pelvic limb arteriovenous fistula has been described so far. All of the previously reported cases were acquired lesions [7, 10, 17, 23, 26, 28]: three cases were post-traumatic (e.g.
Clinical features of AVF depend on the location of the lesion and its hemodynamic consequences [5, 22, 29]. Regarding hepatic AVF in cats, the presence of peritoneal effusion due to portal hypertension has been described previously [22, 23]. For peripheral AVF in cats, clinical signs include swelling of the limb that is associated with severe edema of the extremity [7, 10, 17, 23, 26, 28]. Dermatological lesions are frequently present as erythema and ulceration, crustung, paronychia, and severe bleeding [23, 26, 28]. As noted in the above described case, an aneurysmal and tortuous appearance of the involved vessel may be detected macroscopically [7, 26, 28]. Upon auscultating the area, a pulsatile thrill can be felt that is associated with a continuous murmur [5, 11, 26]. A pathognomonic but inconsistent feature of AVF is the Nicoladoni-Braham sign initially described in human medicine [8, 11, 15] and reported once in cats [26]. This sign is characterized by a decrease in the heart rate and an increase in blood pressure that immediately follows the sudden occlusion of an AVF. Branham’s sign, which causes bradycardia by stimulation of baroreceptors, is suspected to be a reflex [5, 11, 26]. In the present case, chronic, non-healing swelling of the interdigits, severe edema, and lameness of the left pelvic limb were the main signs at presentation. No thrill, murmur, or Nicoladoni-Braham signs were present.

In human and veterinary medicine, traditional angiography and fluoroscopic angiography with contrast media have been the most frequently used diagnostic methods. Angiography examination usually reveals the presence of an interrupted vessel associated with a large complex network of vessels (i.e. neovascularization and anastomosis) distally to the malformation. A mass of tortuous vessels is also commonly present [7, 26]. More recently, invasive techniques have been replaced by color echo-Doppler examination [5, 7, 10-11, 17, 23, 26, 28]. In humans, color Doppler ultrasonographic characteristic findings for AVF include: low-resistance flow in the supplying artery, a high-velocity arterialized waveform and dilatation in the draining vein, as well as turbulent high-velocity flow spectrum at the junction [14]. Data evaluating peripheral blood flow resistance is lacking in veterinary medicine. Further studies are hence warranted in order to describe normal and pathological peripheral Doppler blood flows. Contrast-enhanced CT and MRI have been shown to be more sensitive for the localization and identification of small vascular abnormalities in humans [20]. It may also be possible to identify AVF by use of Dual phase angiography [3, 22, 29, 31], which is commonly used for individualized arterioporal AVF. Moreover, the use of a 3D image reconstruction has been shown to be essential for planning prior to surgery [23]. However, color echo-Doppler ultrasonography has been a preferred diagnostic modality with infants and children, as well on two occasions in equine medicine, in light of its availability and non-invasiveness [9, 14, 18, 30]. It can be rapidly and accurately performed without sedation, and it has the capacity for real-time multiplanar imaging to elucidate the characteristics of the vascular abnormality. The use of continuous wave acoustic Doppler examination in veterinary medicine has not been described previously. In the present case, it allowed for confirmation of a suspected AVF. This procedure was non-invasive and sufficiently reliable to raise clinical suspicion. Furthermore, continuous wave acoustic Doppler machines are generally readily available due to their common use for arterial blood pressure measurements or anesthesia monitoring. Typical arterial blood flow exhibits a pulsatile sound, while typical venous blood flow exhibits a continuous sound. AVF can be suspected when a continuous sound with a pulsatile component (i.e. a ‘machine-like’ sound) is detected while placing the probe on a dilated vein. Color echo-Doppler interrogation is also a non-invasive and readily available technique, although data evaluating normal peripheral blood flow are lacking in veterinary medicine.

In this case, the defect occurred late in life, and a congenital AVF was therefore considered unlikely. As scars, consistent with bite wounds, could be seen on the proximal part of the affected limb, previous cat bites may have had led to wound healing and peripheral AVF development. In humans, other differential diagnosis of aneurysmal dilation of veins includes acquired processes, such as vasculitis and connective tissue disorders. Histological examination of the resected vessel wall did not reveal inflammatory lesions and fibrotic changes seen were considered to be consequences of the suspected bite and chronic AVF.

Treatment of AVF includes ligation or embolization of either the AVF or the arteries and veins, depending on the location (e.g. proximal versus distal to the fistula) and morphology of the lesion (e.g. with or without vascular reconstruction). The prognosis then depends on the size and caliber of the involved vessels, as well as their location [7, 10-11, 14, 17, 22-23, 26, 28, 29]. In human medicine, surgical excision of the fistula and secondary angioplasty is frequently used [8, 11, 14-15]. In veterinary medicine, surgical excision has been the traditional treatment option, although it is sometimes not considered to be feasible due to the largely defective vasculature of the entire limb [7, 11, 17, 22, 26, 29]. Limb amputation could also be a consideration in the latter case in particular [23]. Angioplasty following AVF ligation is non-necessarily required in dogs and cats in light of extensive collateral circulation [23, 29]. Sclerotherapy via catheter embolization of the vessels, with or without surgical excision, has emerged as the treatment of choice for arteriovenous malformations in humans [8, 11, 14-15] and has been reported in 2 dogs [4, 24] and one cat [28] for peripheral AVF. The aim of this procedure is to embolize (with embolic agents as coil or glue mainly) the supplying artery close to the abnormal communication either to highlight it before surgical excision or to directly treat it by occlusion. This procedure has several limitations. It involves availability of skilled specialists and specific tools (fluoroscopy imaging). Significant risk of incomplete occlusion of the vessel have
often been reported. Consequently, the procedure is relatively limited with the exception of cyanoacrylate described as an adjunctive agent used to highlight the vascular lesion preoperatively to facilitate surgical excision and reduce the risk of bleeding in case of complex vascular network. Several complications have been reported including pyrexia, local tissue reaction and embolisation of vessels distal to the fistula (pulmonary vasculature could be implied) [8, 11, 14-15, 28].

Although rare in veterinary medicine, AVF should be included in the differential diagnosis of abnormal dilatation of a vessel in a limb and use of continuous wave acoustic Doppler and color echo-Doppler considered as viable diagnostic procedures. Data on physiological peripheral venous and arterial blood flow are however lacking for dogs and cats, and these hence warrant further study.

Conflict of interests
None.

References

25. - SHAIKH L.S., HOLMES S.P., SELBERG K.T., JARRETT C., HOLLADAY S.D., THOMASON J.,


