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Source: Journal of Feline Medicine and Surgery Open Reports, 2(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/2055116916646387

Case Report

jfms OPEN REPORTS

Journal of Feline Medicine and Surgery Open Reports
1–7

DOI: 10.1177/2055116916646387
jfmsopenreports.com

This paper was handled and processed by the European Editorial Office (ISFM) for publication in JFMS Open Reports

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Retrograde migration and subcutaneous coiling of the peritoneal catheter of a ventriculoperitoneal shunt in a cat

Sinead E Bennett and Sebastien Behr

Abstract

Case summary Ventriculoperitoneal shunt placement is the most commonly utilised surgical treatment for hydrocephalus in human and veterinary patients. Migration of the peritoneal catheter is an uncommon but well-documented complication in people, usually occurring within the first 3 months postoperatively, although only a single feline case report exists. A ventriculoperitoneal shunt was placed in a domestic shorthair cat, aged 4 years and 10 months, following a diagnosis, with MRI, of unilateral, non-communicating hydrocephalus. Diarrhoea, increased vocalisation and pruritus were reported within the first 3 months postoperatively. A shunt-associated seroma developed, which was aspirated under ultrasound guidance. Within 3 days, the entire peritoneal catheter was subcutaneously coiled at the level of the seroma. The peritoneal catheter was replaced within the abdomen via a new subcutaneous tunnel. No further complications had occurred 24 months following revision surgery.

Relevance and novel information This is the second report describing peritoneal catheter migration in a cat. Repetitive head and neck movements during self-grooming, raised intra-abdominal pressure secondary to vocalisation and tenesmus, and negative pressure exerted during seroma aspiration may have contributed to ventriculoperitoneal shunt migration. Excessive loose skin and increased activity may further increase the risk of migration in cats. Diagnostic imaging should be offered prior to and following aspiration of shunt-associated swellings, and minimal negative pressure should be exerted. Attempts to reduce the frequency of postoperative self-grooming, prevention and prompt treatment of conditions predisposing to raised intra-abdominal pressure and moderate exercise restriction, particularly within the first 3 months, may help reduce the risk of peritoneal catheter migration.

Accepted: 1 April 2016

Introduction

Hydrocephalus refers to the accumulation of excessive cerebrospinal fluid (CSF) within the brain or cranial vault.[1] Medical treatment of hydrocephalus, which aims to reduce CSF production, is usually only palliative.[2–4] Surgical shunting of CSF from the ventricular system to another body cavity, usually the peritoneum and less often the right atrium, is the gold standard treatment in people, and can provide a superior long-term prognosis.[2,4] Ventriculoperitoneal shunt (VPS) placement is the most commonly utilised surgical procedure in human and veterinary patients with hydrocephalus.[5,6] Despite this, complications following VPS surgery are common, with failure rates in people of up to 50% within the first year.[7] Mechanical failure remains the most common cause of VPS malfunction in people, with shunt obstruction being the leading cause (46%), followed by shunt disconnection,[8] infection (with reported rates of 4–10%

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and 7.6%)[2,8] and over-drainage. Recent veterinary studies have reported complication rates of 22%, 25% and 29%.[9–11] In one study, shunt occlusion and infection occurred in 11% and 8.5% of animals, respectively,[9] although the patient numbers were vastly lower than those in human studies. Retrograde migration of the peritoneal catheter (PC) to the ventricle, the subgaleal space and the subcutaneous tissues of the head, neck and chest, often with coiling of the catheter in areas of loose skin, has been described in several human case reports,[12–25] although this remains a much less common mechanical complication. Martinez-Lage et al reported an incidence of 0.6% in 500 human shunt procedures,[17] and Sayers reported PC migration resulting in shunt malfunctions in only 3/1390 cases.[26] There is very limited literature regarding postoperative complications of VPS in veterinary patients and a distinct lack of information regarding the incidence of retrograde migration of the PC, especially in cats. To our knowledge only a single case report exists in the Japanese veterinary literature, describing PC migration to the subcutaneous tissue of the dorsal chest in a cat and drainage tube obstruction 5 years postoperatively in another cat,[27] along with a further report describing multiple episodes of kinking of the PC in a cat.[28] This case report describes the retrograde migration and subcutaneous coiling of the PC of a VPS, detected 72 h following percutaneous aspiration of a VPS-associated seroma in a cat with non-communicating, unilateral hydrocephalus. The possible contributing factors to this complication are discussed.

Case description

A male neutered domestic shorthair cat, aged 4 years and 10 months, was presented with a 3 week history of episodic, anticlockwise circling. Long-term poor vision and generalised ataxia were also reported. Neurological examination revealed mild generalised ataxia and proprioceptive deficits, a wide-based pelvic limb stance, bilaterally absent menace responses, poor visual tracking and good visual placing responses. A forebrain lesion was suspected. Routine haematology, serum biochemistry and systolic blood pressure were unremarkable.

MRI of the brain was performed (GE Signa HDe 1.5-Tesla MRI scanner). There was marked, unilateral, right lateral ventriculomegaly. T2-weighted hyperintense material, which was suppressed on fluid-attenuated inversion recovery images, filled the uniformly enlarged ventricle. A moderate-to-severe mass effect was evident, with contralateral deviation of the midline and compression of the thalamus, the rostral colliculus and the rostral aspect of the mesencephalon, indicating caudal subtentorial herniation and raised intracranial pressure. There was a reduction in thickness of the cerebral mantle overlying the enlarged ventricle and asymmetry of the calvarium. There was rostral bulging of the frontal bone with subsequent reduction in the volume of the right frontal sinus, within which an incidental small frontal sinus cyst was identified (Figure 1).

The MRI findings were compatible with non-communicating hydrocephalus, with gross changes indicative of chronicity, although no underlying aetiology could be identified.

Levetiracetam (25 mg/kg IV q12h, Keppra; UCB) and prednisolone (1 mg/kg PO q24h for 2 weeks followed by 0.5 mg/kg q24h, Prednidale; Dechra) were initiated, with minimal response after 2 months. The owner subsequently elected for VPS placement.

A PC (open end with wall slits, standard, pliant, barium impregnated, 90 cm [reference 43551; Medtronic]) was placed intraperitoneally via a right lateral laparotomy and anchored to the abdominal wall with a Chinese finger-trap nylon suture. The PC was subcutaneously tunnelled cranially in a straight line to the level of C1–C2 on the dorsal midline. Using a right lateral rostrotentorial approach, a semi-lunar incision was made over the right calvarium from the caudal aspect of the frontal sinus to the level of C1–C2. Two holes were drilled in the skull approximately 30 mm and 25 mm cranial to the occiput and 1.4 mm lateral to the midline. The dura was incised and the cerebral cortex perforated with a Rivulet ventricular catheter (barium-impregnated, 15 cm [reference 41701; Medtronic]) via the first hole, which was secured into the right ventricle with two nylon sutures anchored to the second hole. CSF flow through the ventricular catheter was confirmed. The ventricular catheter was connected to a CSF flow control valve (FCV) (ultra-small, low-low pressure [reference 22017 B-LL; Medtronic]) at the level of C1–C2, which was secured to the PC caudally. The PC was concertinaed into three loops (perpendicular to the axis of the neck) before connection to the FCV, to allow for movement. Satisfactory positioning of the VPS was confirmed on postoperative CT scan (Figure 2). Recovery was unremarkable and postoperative neurological examination revealed mild generalised ataxia and proprioceptive deficits, bilateral mydriasis and reduced menace responses with good vision. Postoperative analgesia was provided with methadone (0.1–0.2 mg/kg IV q4–6h, Comfortan; Dechra Veterinary Products) and subsequently with buprenorphine (0.02 mg/kg IV q6–8 h, Vetergesic; CEVA Animal Health). The patient was discharged 48 h postoperatively with gabapentin (10 mg/kg PO q12h for 1 week), amoxicillin/clavulanic acid (12.5 mg/kg PO q12h for 2 weeks, Synulox; Zoetis UK), levetiracetam (25 mg/kg PO q12h for 2 months, then q24h for 1 month) and prednisolone (1 mg/kg PO q24h for 1 week, then 0.5 mg/kg q24h for 3 weeks, then 0.5 mg/kg q48h for 6 weeks). There was mild deterioration of the neurological examination 12 h postoperatively; bilaterally, mildly reduced

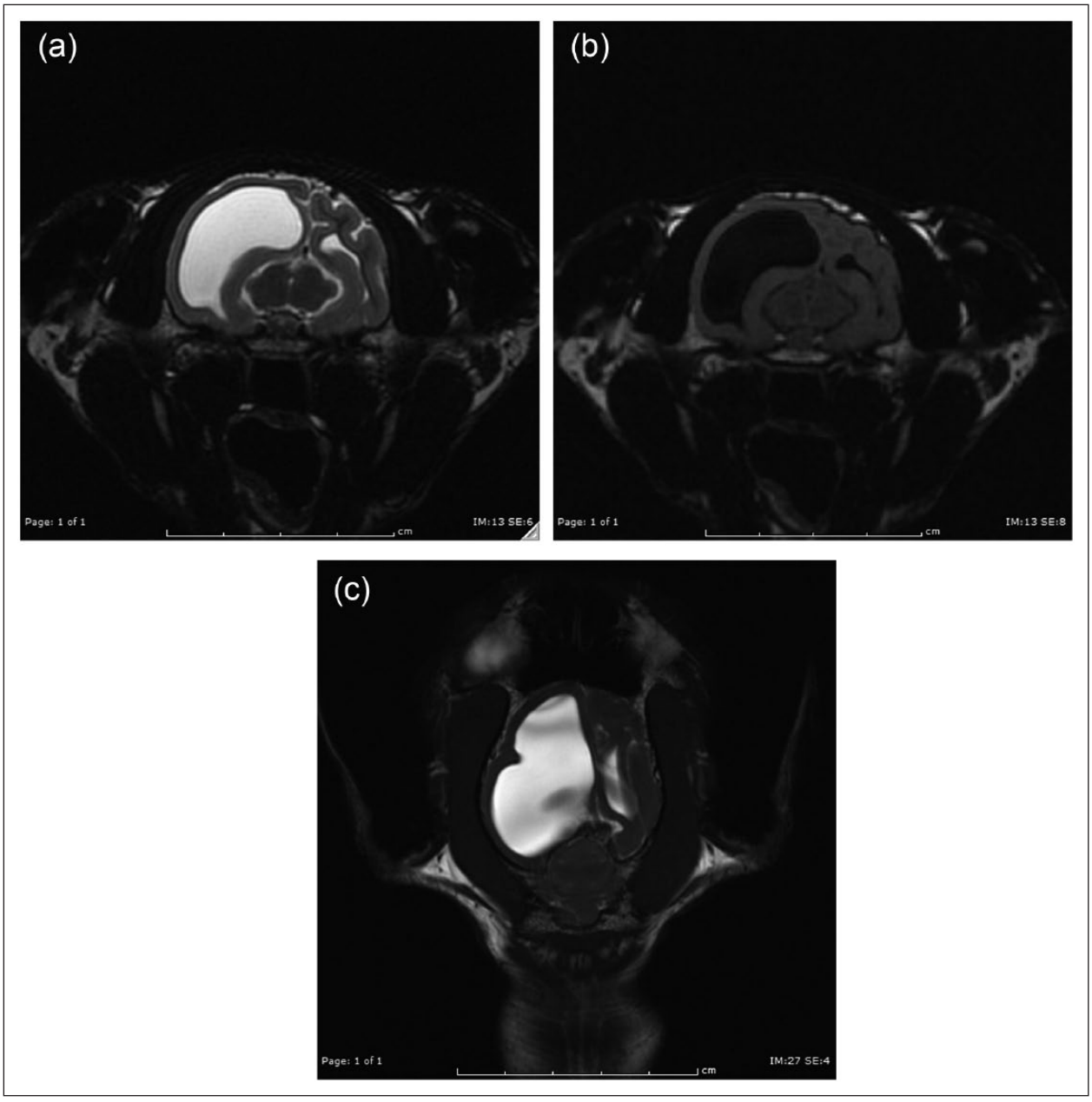

Figure 1 MRIs of the brain demonstrating right unilateral congenital hydrocephalus: (a) axial T2-weighted, (b) axial T2 fluid-attenuated inversion recovery and (c) dorsal three-dimensional fast imaging employing steady-state acquisition

nasal sensation and mydriasis had developed, both of which had resolved at 36 h and 2 weeks postoperatively, respectively.

A 48 h period of loose faeces was reported 2 weeks postoperatively, which resolved spontaneously. Increased vocalisation and polyphagia was reported until at least 8 weeks postoperatively, likely secondarily to prednisolone. Neurological examination had improved 13 weeks postoperatively; a very mild generalised ataxia and proprioceptive deficits and bilaterally reduced menace responses were detected. All medications had ceased 2 weeks earlier. Persistent, generalised pruritus was reported; a flea infestation had been identified and treated with selamectin (Stronghold; Zoetis UK); however, no environmental parasiticide treatment had been applied. A soft, non-painful, 4 cm diameter subcutaneous swelling was present at the level of the CSF FCV, which had developed over the previous 3 weeks. Ultrasound performed prior to seroma aspiration revealed a small length of coiled VPS tubing within the

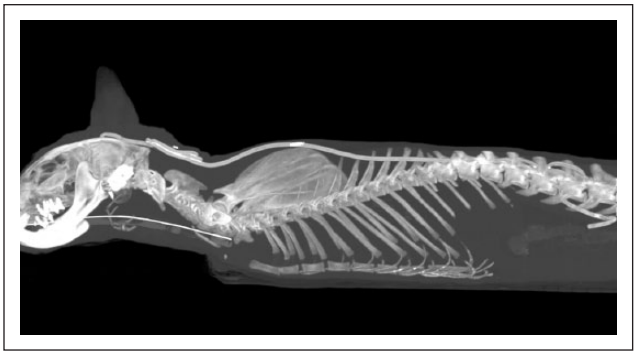

Figure 2 CT rendering sagittal image demonstrating satisfactory positioning of the ventriculoperitoneal shunt

seroma (consistent with original placement) and thus radiography was not performed. Serous fluid (15 ml) was aspirated using a 5 ml syringe and 23 G needle. In-house cytology (cytospin) revealed a mixed-cell population consisting of non-degenerate neutrophils and macrophages, and no evidence of intra- or extracellular bacteria. Culture of the fluid was not performed. Palpation post-aspiration did not reveal an abnormal volume of coiled catheter within the seroma. Meloxicam (0.05 mg/kg PO q24h, Metacam; Boehringer Ingelheim) was instituted along with cold packing of the region q8h. The swelling reformed after 3 days but was palpably firm and approximately 7 cm in diameter. Radiography confirmed cranial migration and subcutaneous coiling of the entire PC within the subcutaneous tissues at the level of the FCV (Figure 3).

The swelling was surgically explored under general anaesthesia. No adhesions between the subcutaneous tissues and the catheter tubing were noted. The PC was flushed to confirm patency and re-tunnelled to the right abdominal wall and secured intraperitoneally. At the time of writing, there had been no further complications 24 months following revision surgery. The owners reported a persistent, marked improvement in coordination and gait, and cessation of circling and compulsive pacing since VPS placement.

Discussion

To our knowledge, this is the second report of migration of the PC of a VPS in a cat.[27] In people, PC migration mostly occurs within the first 3 months of shunt placement,[20,21] as occurred in this case. Multiple episodes of under-shunting due to kinking of the PC, requiring invasive care, were reported in a cat within the first 3 months of surgery,[28] although subcutaneous coiling of the PC was not reported in that case. No shunt complications were seen 360 days postoperatively compared with 24 months in the current case.[28] The current treatment recommendation is surgical removal and replacement of the PC within a new subcutaneous tunnel.[21]

Ultrasonographical evaluation of the seroma in this case confirmed a normal length of PC at the level of the FCV and thus radiography to confirm the intra-abdominal positioning of the PC was not performed prior to seroma aspiration. Consequently, it is unclear whether PC migration began prior to or following seroma aspiration. If the former is true, then perhaps this afforded increased mobility of the FCV and contributed to seroma formation. Conversely, the size of the FCV represents a significant foreign body in a cat and thus seroma formation would have been feasible in the absence of PC migration.

Several mechanisms for PC migration have been suggested in the human literature. Pang and Wilberger suggested that subgaleal fluid re-absorption may create negative pressure, drawing the PC proximally.[12] Alternatively, upward migration may be afforded by a combination of suction from negative intraventricular pressure created due to CSF drainage, pushing from positive intra-abdominal pressure (IAP) secondarily to physiological processes or excessive CSF volume within the abdomen, a tortuous subcutaneous tunnel and a lack of appropriate fixation of the proximal and distal ends of the VPS tubing.[29,30] In the current case, the subcutaneous tunnel was created in a straight line using minimal dissection and the PC was secured in the abdomen by a nylon Chinese finger-trap suture, ensuring adequate fixation. Soft faeces were documented for 48 h within the initial postoperative period, although the occurrence of significant tenesmus could not be confirmed. The owners also reported a noticeable and persistent (for at least 8 weeks postoperatively) increase in vocalisation, seemingly associated with polyphagia, which was thought to be related to tapering prednisolone therapy. It is feasible that raised IAP generated by increased vocalisation and possibly tenesmus may have facilitated PC migration prior to seroma aspiration.

Scott et al first introduced the concept of the 'windlass effect', whereby a proximal anchoring point, such as granulation tissue, allows tension from repeated flexion–extension movements of the head, noted in some hydrocephalic infants, to be transmitted to the PC, creating a proximal winching effect.[31] No obvious adhesions anchoring the PC to the surrounding tissues (which might have created a 'windlass effect') were apparent during the revision surgery. However, considering the range of motion of the feline head and neck it is possible that a similar 'windlass effect' may be generated by the repetitive flexion, extension and twisting movements that occur during self-grooming and scratching, potentially increasing the risk of PC migration in cats. A high frequency of self-grooming and pruritus was observed in this case prior to representation and

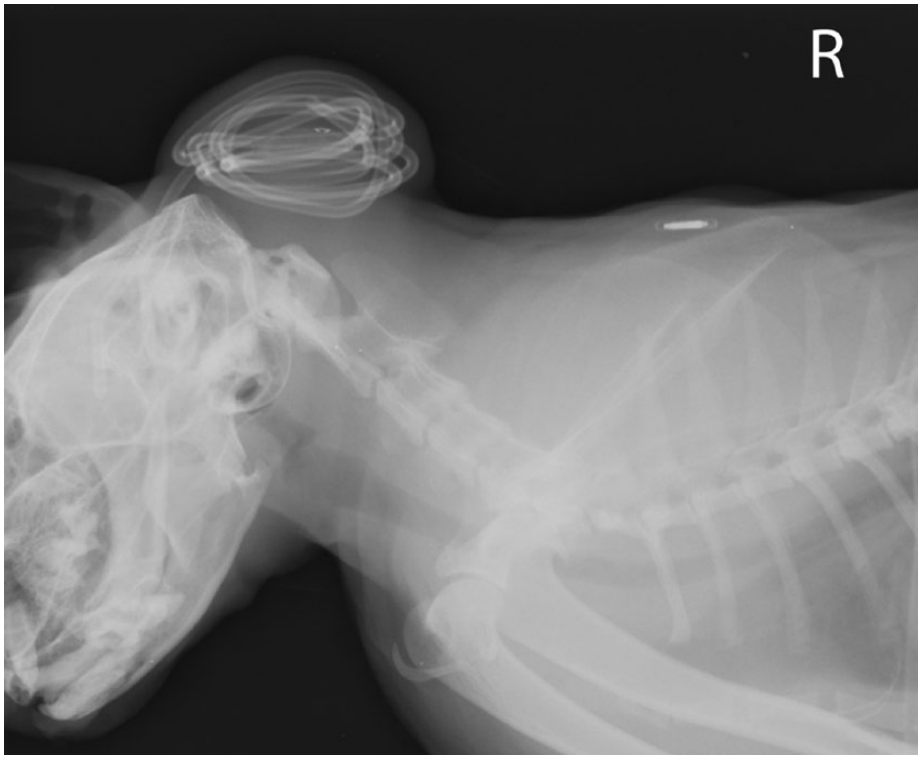

Figure 3 Lateral radiograph demonstrating proximal migration and coiling of the entire peritoneal catheter within a seroma at the level of C1

seroma aspiration, likely secondary to a flea infestation, which may have contributed to PC migration and also possibly to seroma formation due to increased movement of the FCV. Heim et al considered the 'windlass effect' to cause PC migration in an infant with compulsive flexion–extension head movements.[13] They subsequently re-tunnelled the PC away from the axis of the head movements. Further studies would be required to establish whether an optimal shunt pathway exists in cats that would significantly reduce the risk of PC migration.

It is possible that the seroma itself may have caused irritation and increased self-grooming, exacerbating the risk of PC migration. However, the owners reported a generalised pruritus which was not specifically at the level of the seroma and there was no reaction to seroma palpation, making this less likely.

A facilitatory role of loose subcutaneous tissue has been suggested, whereby reduced resistance to catheter movement augments the proximal migration and coiling process.[12,14] Several human reports describe the coiling of a migrated catheter within subcutaneous regions with a previous history of fluid accumulation.[12,14,18] Softer, more mobile skin may further explain the higher incidence of catheter migration to the proximal subcutaneous regions in children than in adults.[14] The seroma in the current case created an area of loose subcutaneous tissue, which may have aided PC migration and coiling. Furthermore, compared with human infants, cats have more substantial amounts of loose, mobile skin, especially along the dorsolateral occipital, cervical and cranial thoracic regions, which may further predispose this species to proximal PC migration. Minimal undermining of the subcutaneous tissues when creating the tract for the shunt tubing may be even more crucial in cats than in people.

Martinez-Lage et al proposed a mechanism whereby rapid release of the PC from its anchoring point around the abdominal scar could be facilitated by abrupt stretching.[17] Subsequent leakage of CSF from the catheter and distension of the subcutaneous tunnel could reduce resistance to retrograde movement of the catheter. The distension of the subcutaneous tract could act as a buffer and account for the initial lack of neurological signs of raised intracranial pressure seen in some people with VPS migration,[16,19,32] as was seen in this case. Normal feline activities (eg, jumping, climbing and hunting) could trigger the above proposed mechanism, perhaps creating an increased risk of PC migration in cats that are younger, more active and/or have an outdoor lifestyle

compared with those cats that are older, less active and/or confined indoors.

Seroma aspiration may have exerted negative pressure on the PC, drawing it proximally and facilitating either dislocation of the catheter from the peritoneum, or proximal migration of an already displaced, extraperitoneal catheter, or perhaps both. Gentle suction was applied using a small-volume (5 ml) syringe to minimise negative pressure. However, considering that ultrasound identified a normal volume of catheter within the seroma prior to aspiration, that the entire PC was radiographically confirmed to be coiled within the seroma within 3 days of aspiration and that no further complications occurred following revision surgery, seroma aspiration may have been a significant contributor to PC migration and subcutaneous coiling in this case.

The shunt tubing used in this case was packaged in a coiled fashion. Dominguez et al considered that the memory of the shunting device, due to coiled packaging, could enable recoiling within the subgaleal space.[25] However, a similar case of upward catheter migration and subgaleal coiling has been described with uncoiled catheter packaging. Furthermore, head motion of this infant was prevented, discrediting the windlass mechanism in this case. In addition, no marked dissection or subgaleal fluid was documented at the revision surgery, making reduced resistance to tube movement and negative suction pressure less likely mechanisms, respectively. No association was found between the type of shunting device employed and the tendency towards upward migration.[19]

The main limitations of this case report are the lack of imaging of the distal PC to confirm its location prior to seroma aspiration and the lack of veterinary literature documenting VPS catheter migration in cats to assess the significance of the observations made.

Conclusions

Migration of the PC of a VPS most commonly occurs within the first 3 months following placement,[20,21] with several possible mechanisms of migration suggested. Preventive measures include proper fixation of the proximal and distal ends of the VPS, minimal dissection when creating the subcutaneous tunnel and straight placement of the tubing.[12,14,19,29] Shunt positioning away from the axis of repetitive head movements may also be beneficial,[13] although the optimal shunt pathway in the cat is yet to be determined. In the current case, an increased frequency of vocalisation (possibly associated with polyphagia secondary to prednisolone therapy) and diarrhoea causing subsequent raised IAP and repetitive self-grooming/scratching creating a 'windlass effect' may have contributed to catheter migration. Thus, cats displaying a high frequency of vocalisation, tenesmus and/or self-grooming, including long-haired cats and those receiving treatment (eg, prednisolone), or with comorbidities that may exacerbate these behaviours, may be at a higher risk of VPS shunt migration. Measures to reduce the frequency of postoperative self-grooming and/or pruritus (eg, encouraging owners to groom their cat, reducing stress, minimising the duration of steroid treatment and preventing/treating comorbidities), appropriate prevention and/or prompt treatment of conditions predisposing to raised IAP and moderate exercise restriction, particularly within the first 3 months, may help reduce the risk of peritoneal catheter migration in feline patients following VPS placement. Negative suction pressure exerted by aspiration of a FCV-associated seroma may have initiated or contributed to PC migration and subcutaneous coiling in the current case. Subsequently, diagnostic imaging should be offered, ideally pre- and postaspiration of a VPS-associated seroma, with appropriate aspiration technique and equipment employed (applying slow, controlled suction using a small-volume syringe with or without a butterfly catheter) to minimise negative suction pressure and the potential risk of catheter migration. Further studies are needed to corroborate these observations.

Acknowledgements We would like to acknowledge the following colleagues for their contribution to this case report: Rob White, Paul Mahoney, Stephanie Piazza, Andrew Parry and William Robinson.

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

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