Perianaesthetic management of a Patagonian cavy (*Dolichotis patagonum*) undergoing hemilaminectomy for treatment of acute intervertebral disk herniation

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Abstract

A 7.5-year-old, 5.6 kg female Patagonian cavy (*Dolichotis patagonum*) in thin body condition presented for bilateral pelvic limb paresis. Lumbar intervertebral disk extrusion was diagnosed using MRI and neurological examination. Emergency hemilaminectomy was done on the same day of diagnostics. The cavy was premedicated with intravenous (IV) midazolam (0.3 mg/kg) and ketamine (5 mg/kg) followed by alphaxalone (to effect) for induction and tracheal intubation. Anaesthesia was maintained with isoflurane-in-oxygen and an IV constant rate infusion (CRI) of ketamine and lidocaine (both 0.3 mg/kg/h) and morphine (0.1 mg/kg, once). The CRI continued for 24 hours followed by once daily intravenous buprenorphine (0.03 mg/kg) and subcutaneous meloxicam (0.5 mg/kg). Recovery was calm. The cavy returned to its preoperative behaviour within hours and began eating soon after anaesthesia. Subjectively, the analgesic plan was successful in mitigating post-operative pathological pain. This case report discusses the perianaesthetic management for spinal surgery in a cavy.

BACKGROUND

The Patagonian cavy (*Dolichotis patagonum*), also called a mara, is a large rodent species of the family Caviidae. An adult cavy is 61–81 cm in length and can weigh between 7 and 16 kg.[1, 2] They are proportionally more hare-like than guinea pig-like, with long ears and long, thin limbs. The thoracic limb nails are claw-like with the pelvic limbs more hoof-like.[3]

Intervertebral disk disease (IVDD) is a degenerative disease process of the intervertebral disks and can result in disk herniation. Trauma to the spinal column can also result in disk herniation. Typically, disk herniation is classified as Hansen type I (extrusion of the nucleus pulposus), Hansen type II (protrusion of the anulus fibrosus) or Hansen type III (acute, non-compressive disk disease).

Thoracolumbar disk herniation due to IVDD is commonly diagnosed in domestic canines, with dachshunds being overrepresented.[4] Disk herniation resulting from either trauma or IVDD has also been diagnosed in domestic and nondomestic felids, otters, hedgehogs, skunks and capybara but no record of this condition has yet been described in a Patagonian cavy.[5-7]

Clinical signs, depending on the severity of the thoracolumbar disk herniation, vary from pain and kyphosis to ataxia and pelvic limb paresis to paralysis and loss of deep pain to the pelvic limbs.[4] Early diagnosis and intervention are key elements in treatment. Diagnosis of disk herniation and other spinal cord lesions has become easier with advanced imaging, specifically MRI.

Surgical intervention for spinal cord decompression remains the recommended treatment. However, up until surgical decompression can be performed or in medical management only, maintaining good perfusion of the site of injury (i.e., ensuring adequate oxygenation and delivery of glucose) is paramount for successful return to normal function postoperatively. Using a balanced anaesthetic technique, where multiple drugs are administered at low doses to achieve anaesthesia and analgesia, aids in maintaining normal cardiovascular and respiratory function to ensure optimal perfusion.[8] Furthermore, maintaining optimal perfusion promotes organ homeostasis and a rapid return to normal function post-anaesthesia.[9, 10]

Drugs used for anaesthesia and analgesia in cavies are scantly reported and not only in this species but also in the taxonomic family (Caviidae). Therefore, it is imperative to document cases, such as this one, within Caviidae to improve our understanding of how to manage these often-unfamiliar species.

CASE PRESENTATION

A tame 7.5-year-old, female intact Patagonian cavy weighing 5.6 kg was referred to the Onderstepoort Veterinary Academic Hospital's (OVAH) wildlife department with acute onset of bilateral pelvic limb paresis of unknown cause of 2 days duration.

Upon presentation to the OVAH, the cavy was bright, alert and responsive. Clinical variables were within expected reference intervals, except for being thinner than expected (2/5: 1 – emaciated, 3 - ideal and 5 - morbidly obese; Oxbow Guinea pig body condition scoring chart).[11]

On neurological examination, the patient was paretic in the pelvic limbs with conscious proprioception deficits. Both deep and superficial pain were present bilaterally; however, responses from the right pelvic limb were more delayed than those from the left. Cranial tibial and ischiatic reflexes were hyperreflexic bilaterally. Panniculus reflex was absent caudal to the third to fourth lumbar vertebrae. Neuroanatomical location indicated an upper motor neuron lesion to the thoracolumbar region.

INVESTIGATIONS

Neither serum biochemical nor complete blood count was performed.

Radiographs, under physical restraint, revealed an intervertebral disk space narrowing between the first and second lumbar vertebrae.

An off-site MRI study (Ingenia MRI Unit, Philips) of the thoracolumbar region was performed the following day accompanied by the wildlife veterinarian. The patient was immobilised for this procedure with ketamine (10 mg/kg; Ketamine Fresenius 100 mg/mL, Fresenius Kabi) and medetomidine (0.1 mg/kg; Domitor 1 mg/mL, Zoetis South Africa) intravenously (IV) via a cephalic vein cannula (22G; Jelco, Smiths Medical). During the 40-

minute MRI procedure, oxygen was administered via face mask, and only heart (HR; beats/mimute) and respiratory rate (f_R; breaths/min) were monitored. Following the procedure, the medetomidine was antagonised with atipamezole (0.5 mg/kg; Antisedan 5 mg/mL, Zoetis South Africa) intramuscularly (IM) for transport back to the OVAH. Recovery was uneventful.

DIFFERENTIAL DIAGNOSIS

Lumbar vertebral fracture due to trauma was suspected but ruled out on survey radiographs.

A Hansen Type 1 intervertebral disk herniation with extradural spinal cord compression between the first and second lumbar vertebrae (L1-L2) with focal extensive spinal cord oedema was diagnosed.

LEARNING POINTS/TAKE-HOME MESSAGES

- Endotracheal intubation in a cavy is challenging because they have a narrow gape and palatal ostium. However, using a Miller blade laryngoscope and intubating stylet is a successful for rapid, atraumatic method of intubation in the absence of a rigid endoscope.
- When drafting an anaesthetic plan for an unfamiliar species, it is advisable to use drugs that have been used in a wide range of species with a high therapeutic index. However, drug selection should be based on the desired goals of the individual anaesthetic.
- Maintaining good prefusion to the spine is an essential goal of the anaesthetic plan in patients that have interverbal disk herniation. Therefore, drugs that preserve cardiovascular function by maintaining blood pressure and cardiac output should be used.
- Pain assessment in unfamiliar animals is challenging, but a return to normal behaviour (sleeping, eating and elimination behaviours), activity and lack of interest in the site of surgery could be used as indicators that the analgesic plan is effective.

TREATMENT

The patient was scheduled for an emergency hemilaminectomy on the same day of the MRI. Premedication comprised ketamine (5 mg/kg) and midazolam (0.3 mg/kg, Dormicum 5 mg/mL, Roche Products) administered IV. This premedication facilitated patient trolley transport to the OVAH theatre complex from its enclosure in the wildlife section of the OVAH which was 100 meters away from the theatre. Prior to induction, 5 mL/kg of hydroxyethyl starch (Voluven 6%, Fresenius Kabi) and 10 mL/kg of isotonic crystalloid fluids (Lactated Ringer's Solution, Fresenius Kabi) were bolused intravenously to pre-emptively treat a suspected hypovolaemia from withholding water for 12 hours. Anaesthesia was induced with alphaxalone (IV; Alfaxan 10 mg/mL, Jurox) to clinical effect to allow endotracheal (ET) intubation with a cuffed polyvinyl chloride ET tube (4 mm internal diameter, Kruuse). The cavy was placed in sternal with the assistant supporting the maxilla by a means of a bandage tie posterior to the incisors and the other hand extending the head and neck by gently grasping behind the head. Intubation presented challenges with regard to limited opening of the oral cavity and depression of the base of the tongue. However, visual-assisted ET intubation, with a 100 mm Miller's blade laryngoscope (mandibular body length

approximately 80 mm) and intubating bougie stylet for railroad technique, was successfully achieved with minimal visual trauma.

Anaesthesia was maintained with isoflurane (Isofor, Safeline Pharmaceuticals) in oxygen delivered via a precision vaporiser (Ohmeda Tec 5, GE Healthcare) using a nonrebreathing Mapleson D system. A single bolus of morphine (IV; 0.1 mg/kg; Morphine Sulphate Fresenius PF 10 mg/mL, Fresenius Kabi) was administered preoperatively. An intravenous constant rate infusion (CRI) of ketamine and lidocaine (Lignocaine 20 mg/mL, Bayer), both administered at 0.3 mg/kg/h, was used as part of the analgesic plan. Additional single dose of meloxicam (0.5 mg/kg; Petcam, Cipla Vet South Africa) was administered subcutaneously (SC). An isotonic crystalloid fluid (Lactated Ringer's Solution) was administered at 5 mL/kg/h during anaesthesia. An injection of enrofloxacin (SC; 5 mg/kg; Baytril 50 mg/mL, Bayer) was administered.

Once in theatre, the cavy was instrumented with a three-lead electrocardiograph (RA, LA, LL; lead II) for HR, sidestream capnography for end-tidal CO_2 tension ($PE'CO_2$), end-tidal inhalation agent concentration (FE'Iso) and f_R, oesophageal thermometer for body temperature (°C), non-invasive oscillometric blood pressure (size 2 cuff; distal radius of right thoracic limb) for systolic, diastolic and mean arterial blood pressure (SBP, DBP, MAP, respectively; mmHg), and transmission pulse oximetry (SpO_2; positioned on the tongue) for continuous monitoring using a multiparameter monitor (CardioCap 5; GE Healthcare). Physiological variables were recorded at 5-minute intervals but reported in Table 1 at 15-minutes intervals. A forced warmed air device (Bairhugger, 3 M) and a resistive polymer heating pad (HotDog, Augustine) were used intraoperatively, as needed, to maintain normothermia. The patient's eyes were lubricated (Celluvisc, Allergan) at 30-minute intervals. Prior to closing of the musculature layer, an infiltrative/splash block with 1 mg/kg lidocaine was performed for post-operative analgesia. The surgery lasted 65 minutes with a total anaesthetic time of 130 minutes.

TABLE 1. Physiological variables of a 7.5-year-old female Patagonian cavy undergoing anaesthesia for surgical decompression of a lumbar intervertebral disc extrusion. Variables are reported at 15-minutes intervals from induction of anaesthesia (T0) and where T60 coincided with start of surgery and T130 termination of anaesthesia

Variables	**T0**	**T15**	**T30**	**T45**	**T60**	**T75**	**T90**	**T105**	**T120**	**T130**
HR	104	96	126	154	110	118	121	121	128	130
Beats/min										
SAP					109	123	148	123	115	136
mmHg										
MAP					80	90	98	98	81	97
mmHg										
DAP					64	70	67	73	60	73
mmHg										
f_R	60	48	48	48	35	28	44	42	60	52
breaths/min										
$PE'CO_2$				34	37	44	41	41	40	40

Variables	T0	T15	T30	T45	T60	T75	T90	T105	T120	T130
mmHg										
FE'Iso				2.7	2.4	1.9	1.4	1.6	1.9	1.7
%										
SpO_2				99	99	97	97	99	98	99
%										
Temp	36.5	36.5	36.1	35.2	35.1	35.2	36.0	36.4	37.0	36.8
°C										

Abbreviations: DAP, diastolic arterial blood pressure; FE'Iso, end-tidal inhalation agent concentration; f_R, respiratory rate; HR, heart rate; MAP, mean arterial blood pressure; $PE'CO_2$, end-tidal carbon dioxide tension; SAP, systolic arterial blood pressure; SpO_2, peripheral oxyhaemoglobin saturation; Temp, body temperature (oesophageal); °C, degrees celsius.

Postoperatively, the cavy was transported to a quiet area in the wildlife section and placed in a cage for confinement for recovery. The recovery was calm, and the ET tube was removed (when the swallowing reflex returned) 15 minute after stopping the administration of isoflurane. Post-operative management included the continuation of the ketamine-lidocaine CRI for 24 hours. Following the completion of the CRI, buprenorphine (0.03 mg/kg; Temgesic, Indivior) was administered IV once a day for 4 days. Meloxicam (0.5 mg/kg) was administered SC for 5 days followed by an additional 3 days of the oral meloxicam (0.5 mg/kg; Petcam 1.5 mg/mL, Cipla Vet South Africa). Enrofloxacin (5 mg/kg; q24h) was administered SC for an additional 4 days. Approximately 2 hours post-extubation the patient was crawling (using thoracic limbs with weak standing effort attempts by the pelvic limbs) around the cage and eating. There was no display of bruxism or clawing and nibbling at surgical site during the post-operative period. However, tenderness adjacent to the surgical area during gentle palpation, identified by flinching without turning its head towards the site of stimulation, was evident 2 hours post-extubation and was not assessed again.

OUTCOME AND FOLLOW-UP

One day post-operative, the cavy could bear weight for short periods of time when assisted. The cavy appeared to have voluntary control for micturition as placement of urinary catheter or urinary bladder expression was not indicated. Four days later, the cavy was able to stand unassisted and able to walk. On the 11th day postoperatively, the cavy had a rigid stance, and ataxic gait appeared to be uncomfortable. The rigidity was thought to have resulted from breakthrough pain and muscle spasms. The pain was treated with a second course of once daily meloxicam (0.5 mg/kg) with the initial dose administered SC followed by *per os* (PO) for 3 days. The muscle spasms were treated with once daily midazolam (0.1 mg/kg), administered IM, for 3 days. The cavy responded well to this treatment within a day. The cavy remained hospitalised for a further 9 days for strict cage rest before being discharged from the OVAH into the care of the owner. The cavy was doing well 2 months postoperatively, with only a slight ataxic gait being reported.

DISCUSSION

Managing this cavy for spinal surgery highlighted practical learning opportunities. The first was planning an anaesthetic protocol in an unfamiliar species that would promote a return to near-normal behaviour postoperatively. The second was to select analgesic drugs that would not cause post-operative drug-related side effects unrelated to the spinal injury, thus not masking post-operative recovery of function. The third was to determine if the analgesic plan was effective by assessing post-operative pain in an unfamiliar species.

Literature describing perianaesthetic plans in cavies are scant, and only one article could be found.[2, 12, 13] That cavy received buprenorphine (0.02 mg/kg) and was induced and maintained under anaesthesia using sevoflurane in oxygen without further description of the plan.[13] The objective of the perianaesthetic plan in our cavy was to maintain perfusion to the spinal cord, because perfusion is a critical determinant of post-operative success in managing disk herniations in dogs and humans.[9, 10, 14, 15] A midazolam-ketamine combination is known to preserve or even improve cardiovascular function by maintaining or increasing arterial blood pressure and cardiac output in a wide range of species.[8] However, this cardiovascular effect is indirect, whereby ketamine prevents the reuptake of norepinephrine at the neuro-effect junctions of the sympathetic nervous system.[8] Cavies are prey species which are known to have a higher resting sympathetic tone.[12] Isoflurane, when administered alone, can cause a decrease in systemic vascular resistance whereby decreasing the blood pressure and possibly cardiac output which could result in a decrease in perfusion to the traumatised spinal cord. Therefore, a partial intravenous anaesthetic technique was chosen, and the ketamine-lidocaine CRI was used to decrease the dose of isoflurane administered. The FE'Iso was higher than required until it was titrated downwards at T60 and during the surgery. This FE'Iso (between 1.4% and 1.9%) was similar to 1.5 times the minimum alveolar concentration (MAC) for guinea pigs (being in the same family Caviidae) of 1.2%.[16] Anaesthetising animals at a multiple of 1.5 times, the MAC is a common guideline to ensure an adequate depth of anaesthesia, especially during spinal surgery, is maintained.[8, 16] However, despite our intention for isoflurane reduction, the ketamine-lidocaine CRI was infused at conservative doses, and therefore we speculate that it did not decrease the isoflurane requirements. Regardless, the criteria for maintaining cardiovascular performance were achieved by maintaining the mean arterial blood pressure above 70 mmHg for the duration of the surgery, as is advocated to ensure good intraoperative perfusion to the site of spinal trauma.[9, 10, 15] The safest technique of delivering isoflurane (and other inhalation anaesthetics) is via an ET tube connected to a breathing system that does not leak. Tracheal intubation in unfamiliar species can pose of lot of pre-procedure anxiety to the anaesthetist because it is uncertain when you will be challenged with a life-threatening complication. Cavies are obligate nasal breathers, and complications can arise if too much time is wasted during ET intubation or if the nostrils are accidently obstructed.[12] Furthermore, the soft palate is fused to the base of the tongue, and the presence of a palatal ostium, an opening in the soft palate, allows entry to the glottis. This makes ET intubation challenging. It has been advised to use a rigid endoscope for intubation which minimises trauma to the rima glottidis or the highly vascular palatal ostium.[2] Due to the unavailability of an endoscope, a Miller blade laryngoscope and intubating stylet were successful and represent a viable alternative technique. Another important consideration in managing spinal cases is to minimise and prevent further inflammation which was the focus of our analgesic plan.

The analgesic plan aimed to treat inflammation and to prevent or minimise neuroplasticity (central sensitisation) of the second order neurons of the spinal cord. Meloxicam was selected as the non-steroidal anti-inflammatory drug because it has a good therapeutic index in a range of species and has been commonly administered to Caviidae animals. A ketamine-lidocaine

CRI was selected to provide continuous hypoalgesia for 24 hours postoperatively. However, deciding on the dose of infusion was debated, and a final dose of 0.3 mg/kg/h for both drugs was initially selected. The advantage of starting at conservative dose rates is that the CRI can be titrated upwards to a desired clinical effect without causing drug-related side effects; however, this was not done in this case.[8] Regardless, at these doses, both ketamine and lidocaine appear to have anti-inflammatory effects.[17, 18] Ideally, before starting an infusion, an intravenous loading dose should be administered. In this cavy, ketamine was administered IV during premedication, but the lidocaine was administered at the site of injury as a splash block before closure. Ketamine infused at 0.12 mg/kg/h has been reported to be at sufficient levels in the cerebrospinal fluid to bind to NMDA receptors, in dogs.[19] Blocking the NMDA receptors is thought to be one of the mechanisms of decreasing or treating neuroplasticity. Neuroplasticity is where the neuron increases its function by increasing the quantity of neurotransmitters being released and increasing the number of receptors for binding.[19] If the second order neurons increase their functional capacity through neuroplasticity, then the signals are sent to the brain, and thus an increased change of experiencing pain can occur. Opioid agonists are considered a gold-standard approach and first-option drug class to treating perianaesthetic pain, especially in dogs, cats and horses. However, concerns regarding perceived side effects, disagreement with the case management and analgesic regimen played a role in the case. Furthermore, an emphasis to explore opioid-free spinal surgery as part of the analgesic plan has emerged.[20] These opioid-free analgesic plans are successful and could become common practice and replace current opioid-based plans. The major advantage of not including opioids is that the common side effects that are known to occur in most species at clinical doses would not be present. These include, but are not limited to, inappetence, decreased gastrointestinal motility and sedation.[8, 21, 22] In the absence of veterinary information of opioid-free spinal surgery, we elected to use opioids very sparingly in this cavy and to administer them as rescue interventions in the event of breakthrough pain. Identifying breakthrough pain was thought to be an obvious diagnosis; however, more challenging in unfamiliar species is to evaluate pain and to titrate the analgesic plan to effect.

Monitoring pain and the effectiveness of an analgesic plan in unfamiliar prey species is challenging. Many pain scoring systems have been derived for laboratory rodents, and this is an active ongoing field of research.[23, 24] Commonly included variables that are assessed during pain scoring are evaluation of activity levels, appearance (grimace, hunched, not grooming, ocular discharge, recumbent), temperament (increased aggression, guarding, reluctance to interact), vocalisation (teeth-grinding, chattering, whining), change in behaviour (decreased food and water intake, reduced body weight, reduced urination and stool output), physiological changes (heart rate, respiratory rate, blood pressure, temperature) and evaluation of the surgical site (erythema, swelling, discharges, reactions to gentle palpation).[24] In this cavy, we used a return to near-normal behaviour as a good indicator that the analgesic plan was effective. Patient evaluation for pain assessment was performed twice a day for the duration of post-anaesthetic analgesia. Qualifiers for assessment included behaviour, appetite, surgical site inspection with palpation of surrounding wound edges. The cavy began eating and passing stools on the same day. The return to standing and walking occurred over a few days, similar to dogs undergoing spinal surgery.[25] Furthermore, no teeth-grinding (bruxism) or other commonly monitored variables indicated the presence of clinical pain. Also, when we discontinued administering analgesic drugs, within a few days (on day eleven) the cavy demonstrated a stiff stance and pronounced ataxia which indicated that the initial analgesic plan was effective. The return to eating and normal gastrointestinal function was imperative to maintain because anorexia, lumbar spinal injury and meloxicam can result

in gastric ulcerations.[8, 26] Subclinical gastric ulcerations, if left unmanaged, can manifest into life threatening post-operative complications in patients undergoing spinal surgery.[26] Therefore, if the cavy continued with a good appetite and passing stools, it was a good indicator that the pain experience was under adequate control. The cavy did flinch at wound palpation but without directly looking at the site of palpation. We speculate that the sensation of touching a shaved surgical site in an exotic animal elicited a reflex response and that it was not a good indicator of overt secondary hyperalgesia. Furthermore, the wound had no signs of erythema, swelling or discharge which suggests the flinch response was less likely to be due to pain.

In conclusion, cavies can develop disk herniation that requires surgical decompression. An anaesthetic plan in unfamiliar species should include drugs that have been used in a wide range of species and meet the goals of the individual anaesthetic. A minimal-opioid analgesic plan can be used in patients undergoing spinal surgery with success. Monitoring pain remains a challenge in unfamiliar species, but a rapid return to function and homeostasis are good indicators that the analgesic plan is effective.

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