Surgical management of vertebral synovial cysts in a rabbit (Oryctolagus cuniculus)

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Case Description—An approximately 8-month-old female Miniature Lop rabbit (Oryctolagus cuniculus) was evaluated because of an acute onset of progressive paraparesis.

Clinical Findings—The rabbit was ambulatory paraparetic, and results of neurologic examination were consistent with a myelopathy localizing to the T3-L3 spinal cord segments. Evaluation with CT myelography revealed focal extradural spinal cord compression bilaterally at the level of the articular process joints of T12-L1.

Treatment and Outcome—A Funkquist type A dorsal laminectomy was performed at T12-L1, and the vertebral column was stabilized with pins and polymethylmethacrylate-based cement. Multiple vertebral synovial cysts were confirmed on histologic evaluation of the surgically excised tissues. The rabbit was nonambulatory with severe paraparesis postoperatively and was ambulatory paraparetic at a recheck examination 7 weeks after surgery. Fourteen weeks after surgery, the rabbit appeared stronger; it walked and hopped slowly but still fell and dragged its hindquarters when moving faster. Thirty-seven weeks after surgery, the neurologic status was unchanged.

Clinical Relevance—Although thoracolumbar myelopathy in rabbits is commonly secondary to vertebral fracture, vertebral synovial cysts should be considered a differential diagnosis for rabbits with slowly progressive paraparesis. Decompressive surgery and stabilization can result in a good outcome for rabbits with this condition. (J Am Vet Med Assoc 2014;244:830–834)

An approximately 8-month-old sexually intact female Miniature Lop rabbit (Oryctolagus cuniculus) was evaluated because of a 3-day history of progressive paraparesis. The rabbit was acquired as a stray 3 months prior and subsequently housed with 1 other domestic rabbit. The rabbit was allowed to roam freely in the house during the day and was crated overnight. The diet consisted of adult rabbit food, a Timothy hay, b and a variety of vegetables. The only known previous medical history was an episode of poor appetite 2 months prior that had resolved within 24 hours with supportive care. There was no known history of trauma. Three days prior to the veterinary visit, the rabbit seemed weak and was observed to drag a pelvic limb during locomotion. In retrospect, the client thought that the rabbit may have missed some jumps onto low furniture and had seemed clumsy when it turned corners for an unspecified length of time. The client also noted that the rabbit would walk around corners, so that one pes was always in contact with the floor, rather than hopping. For the last few days, the rabbit had been scattering fecal pellets as it ran. The day prior to the examination, ataxia had seemed to progress. The rabbit was eating normally and did not have obvious signs of pain.

On initial evaluation, the rabbit was alert and responsive. Heart rate, respiratory rate, and body temperature were within the respective reference ranges, and body weight was 2.2 kg (4.84 lb). Dry fecal material was found adhered to the perineum, but the remainder of the physical examination findings were considered normal. On neurologic examination, the rabbit was ambulatory with moderate paraparesis and general proprioceptive ataxia. Postural reactions (paw replacement test and hopping) were normal in the thoracic limbs and absent in the pelvic limbs. The patellar and withdrawal reflexes were normal in the pelvic limbs. The cutaneous trunci reflex was absent caudal to L2. Thoracic limb reflexes were not assessed. The neuroanatomic localization was within the T3-L3 spinal cord segments. Differential diagnoses included intervertebral disk herniation, congenital malformation (synovial cyst, subarachnoid diverticulum, and hemivertebrae), vertebral fracture, infectious disease (eg, diskospondylitis or encephalitozoonosis), mild traumatic injury with degenerative changes and spinal cord compression, or metabolic bone disease.

The rabbit was administered meloxicam (0.3 mg/kg [0.14 mg/lb], PO, q 12 h) and fenbendazole (20.0 mg/kg [9.10 mg/lb], PO, q 24 h). Results of serologic testing of a blood sample for Encephalitozoon cuniculi were negative, and fenbendazole administration was discontinued after 5 doses. Pack cell volume, total solids concentration, and results of routine serum biochemical analysis were within reference intervals. The rabbit was anesthetized for CT myelography. Following premedication with oxymorphone hydro-
chloride \((0.11 \text{ mg/kg} \ (0.05 \text{ mg/lb})\), ketamine hydrochloride \((11.0 \text{ mg/kg} \ (5.0 \text{ mg/lb})\), and midazolam hydrochloride \((1.1 \text{ mg/kg} \ (0.5 \text{ mg/lb})\) by IM injection, a 24-gauge right auricular IV catheter was placed, and anesthesia was induced with isoflurane delivered via face mask. Inhalation anesthesia was maintained with isoflurane in oxygen for the duration of the procedure (2.5 hours). A balanced electrolyte solution \((10 \text{ mL/kg/h} \ (4.5 \text{ mL/lb/h}), \text{IV})\) was administered throughout the procedure.

A 22-gauge, 1.5-inch spinal needle was placed through the L6-7 interarcuate space with fluoroscopic guidance, and iohexol \((0.18 \text{ mL/kg} \ (0.08 \text{ mL/lb); 24.5 \text{ mg I/lb})\) was injected into the subarachnoid space. Immediately after the injection, the rabbit was placed in dorsal recumbency, and transverse-plane multi-detector row CT images collimated to 1.25 mm and 50% overlap were obtained for the thoracolumbar region of the spinal column from the level of T6-7 through the L7-S1 vertebral articulation. Dorsal and sagittal plane reconstructions were made with a 64-bit Digital Imaging and Communications in Medicine (DICOM) viewer and software. Focally, at the T12-L1 articulation, the spinal cord was severely compressed from the dorsal left aspect and moderately compressed from the dorsal right aspect, with complete attenuation of the contrast column; the spinal cord had a triangular shape in the transverse plane in this region (Figures 1 and 2). At the level of maximal compression, width of the dorsal aspect of the spinal cord was approximately one-third that of the ventral aspect of the spinal cord. The left caudal articular process of T12 was displaced dorsally by approximately 0.1 cm, compared with the right caudal articular process of the same vertebra. Also, the T12-L1 articular facet joints were abnormally widened by fluid-attenuating material, more severely on the left than on the right side. The diagnostic interpretation was severe focal extradural spinal cord compression from the dorsal left (major) and dorsal right (moderate)
aspects at the level of the T12-L1 articular facet joints. The primary differential diagnosis was bilateral articular facet joint synovial cysts. Other differential diagnoses included compression resulting from fibrosis secondary to previous spinal column trauma.

One day after CT myelography, the rabbit was nonambulatory paraparetic with urinary and fecal incontinence. Two days later, the patient’s motor function had improved but it was still nonambulatory. The rabbit was anesthetized for surgery with the previously described anesthetic protocol, and a 2.5-mm endotracheal tube was placed with endoscopic guidance. Cefazolin sodium (22.7 mg/kg [10.3 mg/lb], IV, q 2 h), oxymorphone (0.11 mg/kg, IV, q 2 h), a bolus of hetastarch solution (2 mL/kg [0.9 mL/lb]), and a balanced electrolyte solution (10 mL/kg/h [4.5 mL/lb/h]) were administered during surgery.

The rabbit was placed in sternal recumbency with the pelvic limbs in an extended position. A midline skin incision was made, and a Funkquist type A dorsal laminectomy was performed at T12-L1. The left T12-L1 articular facet joint was cauterized for identification as a landmark for histologic evaluation. The lamina and left and right articular facet joints were removed en bloc. Four 0.9 × 1.1-mm mini-interface pins were placed in the T12 and L1 vertebral bodies at the level of the transverse process, directed ventromedially parallel to the disk space, and stabilized with a polymethylmethacrylate-based cement. A thin piece of gel foam was placed over the exposed region of the spinal cord. Closure was routine. Postoperative radiographs showed that the pins purchased bone and had appropriate trajectory (Figure 3). The rabbit was administered meloxicam (0.3 mg/kg, SC, once, followed by the same dose PO, q 12 h for 9 days) and buprenorphine hydrochloride (0.03 mg/kg [0.014 mg/lb], SC, q 8 h for 5 doses). Following recovery from anesthesia, the rabbit received syringe feedings and remained nonambulatory paraparetic while hospitalized. The rabbit was discharged.
24 hours after surgery with orders for strict cage rest and continued nursing care. The rabbit was seen several times a week by a licensed veterinary physical therapist who developed a home exercise program for rehabilitation.

The excised articular facet joints of T12 and L1 were submitted to the facility's pathology service for histologic evaluation. Two clear-fluid–filled, thin-walled cysts, measuring 0.15 to 0.25 cm in diameter, protruded from the ventral aspect of the en bloc section of the T12-L1 vertebral dorsal lamina and articular facets. On histologic examination, the cysts extended from the ventral surface of the interarcuate ligament, and each was composed of a thin fibrous wall lined by synoviocytes. The larger cyst was on the left side. The smaller cyst on the right side was continuous with the synovium (Figure 4). Within both facet joints, there was widening of the joint space, villous to nodular proliferation of the synovium, joint capsule fibrosis, mild osseous resorption, and periosseous new bone proliferation on both articular processes and the spinous process of L1. Findings were compatible with the diagnosis of vertebral synovial cysts with chronic osteoarthritis.

Seven weeks after surgery, the rabbit was weakly ambulatory with severe paraparesis and proprioceptive ataxia. The rabbit often became laterally recumbent in the pelvic region and hind limbs, instead of holding itself upright. Paw replacement tests were normal in the thoracic limbs and absent in the pelvic limbs. The patellar and withdrawal reflexes were normal in the pelvic limbs, and the cutaneous trunci reflex was normal. Thoracic limb reflexes were not assessed. Radiography of the lumbar region revealed static pin positioning.

Fourteen weeks after surgery, the rabbit was weakly ambulatory with moderate paraparesis and pelvic limb ataxia. The pelvic limb muscle atrophy was less severe than at the 7-week recheck examination. The rabbit was stronger and able to raise its pelvis by pushing with its pelvic limbs. When ambulating slowly, the rabbit walked and hopped, but when moving faster, it fell and dragged the pelvic limbs. Results for the remainder of the neurologic examination were unchanged from the previous visit. The rabbit had regained urinary and fecal continence. The client was satisfied with the outcome and reported that the rabbit had continued improvement without signs of pain. Thirty-seven weeks after surgery, the neurologic status remained unchanged. The owner had constructed a device that, when used to support the abdomen, allowed the rabbit to jump with normal movements without falling.

**Discussion**

To our knowledge, this is the first report describing the diagnosis and surgical treatment of extradural vertebral synovial cysts causing dorsal compression of the thoracolumbar spinal cord in a rabbit. The patient in this report recovered from surgery and had signs of improvement at subsequent follow-up examinations.

The etiology of vertebral synovial cysts is unknown. Extradural synovial cysts have been reported in dogs,1,2 horses,3 and humans.4,5 In dogs, they have been reported to cause progressive cervical or thoracolumbar myelopathy1,2 with associated paresis, proprioceptive ataxia, and signs of pain. Histologic evaluation of the excised tissue typically reveals poorly cellular collagenous tissue with irregular fluid-filled structures lined by a single layer of synovial cells.1 Synovial cysts may occur secondary to osteoarthritis of the facet joints, brought on by mechanical instability.1,3,5 There may be excessive joint mobility, resulting in prolapse of synovium through a defective joint capsule.1,5 In giant-breed dogs, synovial cysts have been associated with cervical spondylomyelopathy, which occurs in young animals and involves malformation and hypertrophy of periarticular soft tissues. It has also been related to degenerative disease and intervertebral disk protrusions affecting the thoracolumbar vertebral column in older large-breed dogs.2 The exact age of the patient in this report was unknown, but it was thought to be < 1 year old. The synovial cysts were most likely secondary to congenital malformation or vertebral instability. Degenerative noncompressive spinal osteoarthritis and spondylosis are encountered in older rabbits and can lead to abnormal gait and reduced grooming of the caudal regions of the body, owing to reduced mobility of the vertebral column.6 However, compressive spinal osteoarthritis has not been reported in rabbits.

Thoracolumbar myelopathy is a commonly observed neurologic abnormality in rabbits, with vertebral fracture or luxation being the most common diagnosis.7 The most common site of fracture is the lumbosacral area.8 Anatomic features such as the heavily muscled hindquarters and long back make rabbits prone to vertebral fractures.6 Inappropriate manual restraint is often at fault for these injuries. Rabbits that are nervous or startled also have been reported to sustain fractures in the process of a sudden jump to escape a threat. Injury occurs when the powerful hind limbs are rotated forcefully about the lumbosacral junction.6 Prognosis after vertebral fracture depends on the severity of the injury. Intervertebral disk herniation is another more common cause of spinal cord injury in rabbits.6 Because the rabbit of this report was previously a stray, the medical history before 6 months of age was unknown. Trauma cannot be ruled out as an underlying cause of the degenerative changes in the joints, although it seems less likely than a congenital malformation. Results of radiography are often diagnostic for vertebral fractures.6

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**Figure 4**—Photomicrograph of a histologic section of the excised articular process joints and lamina at T12-L1 from the rabbit in Figure 1. Multiple synovial cysts extend from the ventral surface of the vertebral arch of T12-L1. The smaller synovial cyst is continuous with the synovial lining of the right articular process joint through a breach in the interarcuate ligament (white arrowhead). Villonodular synovial hyperplasia (black arrowheads) and joint space widening are present in both the right and left articular process joints, and there is mild bony remodeling of the caudal articular process of T12 and cranial articular process of L1 (asterisks). H&E stain; bar = 500 μm.
but advanced imaging such as myelography, CT, or MRI is necessary to assess spinal cord compression.1,2 Radiographic evaluation may reveal periarticular new bone formation, suggestive of degenerative disease of the articular facet joints at the sites of synovial cysts.1,2 On MRI, cysts may be seen as well-defined circular defects that are slightly hypointense on T1-weighted images and hyperintense on T2-weighted images.3 In the rabbit of this report, imaging of the vertebral column by CT with myelography was chosen over MRI because of concerns that the small size of the rabbit would prevent acquisition of high-quality images and that prolonged anesthesia would be required to perform MRI.

Myelography has been reported in rabbits4 and, in this patient, resulted in good-quality diagnostic images. Contrast injection at the L6-7 interarcuate space allowed for a smaller volume to be administered to reach the site of interest, and the small size of the patient may have reduced the risk of iohexol-related seizures or death.5,6 The lesion in this rabbit was visible on lateral and ventrodorsal myelographic views. However, CT was used to better evaluate the extent of bony involvement and to better characterize the lesion.

Encephalitozoon cuniculi is a common cause of neurologic deficits in pet rabbits11 and is most commonly associated with vestibular disease but may also lead to paresis.6,11 It is more common in young rabbits than in older ones. Fenbendazole is an appropriate treatment and was administered to our patient until the negative results of serologic testing for E. cuniculi ruled out this disease.6

The veterinary literature lacks information regarding clinical success of surgical decompression and methods of vertebral stabilization in rabbits. Vertebral stabilization was performed in the rabbit of this report because of concerns of instability and subluxation given the strong interpediculate musculature in the rabbit and the fact that the articular facet joints were removed bilaterally. These surgical techniques have not been adequately described in rabbits.12 This could partly be attributable to the fragile nature of the vertebral column in rabbits, the expense associated with surgery of the vertebral column, the infrequency of advanced diagnostic testing in rabbits, and the need for appropriately trained veterinarians to perform the surgery. Use of surgical pins and polymethylmethacrylate-based cement was elected because it has been shown to provide effective spinal column stabilization in dogs and is easily implanted in any vertebrae without anatomic variation interfering with implant placement.13 Another advantage was the low cost of the implant (approx $270 for materials).

The pins were chosen by measurement of the size of the vertebral bodies on CT images, and anatomic landmarks were used to determine the direction of pin placement. Use of a locking plate was considered, but the cost and lack of sufficiently small sizes of plates or screws as well as the thin vertebral body prevented its use in this rabbit.

Successful medical management of a case of multiple vertebral fractures in a rabbit has been reported.13 Spontaneous resolution of clinical signs has been reported in humans with synovial cysts following reestablishment of stability, rupture of the cyst, or use of medications to reduce inflammation.1 It is possible that the rabbit of this report would have improved neurologically over time with an appropriate course of anti-inflammatory medica-

### References