Dorsal laminectomy for treatment of cervical vertebral stenotic myelopathy in an alpaca

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Case Description—An 11-year-old male breeding alpaca was evaluated for a 2-day history of lowered head carriage and lethargy.

Clinical Findings—On initial examination, the alpaca had signs of lethargy and lowered carriage of the head and neck, but no specific neurologic deficits. Medical management improved the clinical signs, but 8 months later, the alpaca developed acute, progressive general proprioceptive ataxia affecting all 4 limbs and was referred for further evaluation and treatment. Magnetic resonance imaging and CT identified disruption of the normal osseous architecture of C7 and T1. Medical management was attempted, but because of a lack of improvement, the patient underwent surgery 14 months after initial examination.

Treatment and Outcome—A dorsal laminectomy of C7 and T1 via a dorsal midline approach was performed, and the spinous processes of both vertebrae were removed prior to removal of the overlying lamina. Free dorsal expansion of the spinal cord was ensured by resection of the ligamentum flavum. Six months after surgery, the alpaca had returned to successful breeding with 7 hembra bred in the first year after surgery, producing 6 crias, and 4 crias in the second year. The patient was eventually euthanized 28 months after surgery because of neurologic deterioration but was still ambulatory at that time.

Conclusions and Clinical Relevance—A good outcome with adequate alleviation of clinical signs and breeding soundness for > 2 years following dorsal laminectomy was achieved in this camelid patient. The surgical approach was similar to that in other species and was associated with mild postoperative morbidity. Veterinarians treating camelids should be aware of the initial clinical signs and treatment options for cervical vertebral stenotic myelopathy. In acute cases, the signs of reduced cervical mobility and pain on manipulation should prompt investigation including appropriate diagnostic imaging. Timely surgical intervention should be considered in patients that respond poorly to medical treatment to avoid irreversible spinal cord injury and optimize outcome. (*J Am Vet Med Assoc* 2015;246:1122–1128)

An 11-year-old sexually intact male alpaca (*Vicugna pacos*) was examined at the Royal Veterinary College Farm Animal Clinical Centre with a 2-day history of lowered head carriage and lethargy. No neurologic deficits were identified. Results of a CBC and serum biochemical analysis were within reference limits; however, *Mycoplasma haemolamae* was identified on a fresh blood smear. The animal was treated medically with IV fluids (sodium lactate[a] [2 mL/kg/h {0.9 mL/lb/h}, IV, q 4 h, administered as boluses]) and an antimicrobial (oxytetracycline[b] [20 mg/kg {9.1 mg/lb}, IV, q 24 h]) for 5 days, and the clinical signs improved. The alpaca remained at pasture for 8 months but was reexamined for acutely progressive general proprioceptive ataxia affecting all 4 limbs (grade II/IV),[1,2] with caudal cervical hyperesthesia and reduced cervical mobility. Results of a CBC and serum biochemical analysis were again within reference limits.

Radiographic evaluation of the cervical vertebrae (**Figure 1**) identified collapse of the intervertebral disk space at C7-T1 with sclerosis of the vertebral end plates and proliferative new bone on the ventral aspect of the vertebral bodies of C7 and T1. Medical management consisting of stall confinement and rest from breeding activity and NSAID treatment (meloxicam[c] [0.2 mg/kg {0.09 mg/lb}, SC, q 24 h]) was continued until the clinical signs deteriorated 2 weeks later. At that time, MRI was performed under general anesthesia. The patient was premedicated with methadone[d] (0.15 mg/kg [0.07 mg/lb], IV) and xylazine[e] (0.2 mg/kg, IV), followed by induction of anesthesia with propofol[f] (6.0 mg/kg [2.7 mg/lb], IV) and midazolam[g] (0.2 mg/kg, IV). An endotracheal tube was then placed, and anesthesia was maintained with sevoflurane[h] in oxygen. Magnetic resonance imaging[i] of the cervical region identified complete disruption of the normal osseous architecture of the caudal

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Figure 1—Laterolateral radiograph of the caudal cervical vertebrae of an 11-year-old sexually intact male alpaca with a history of lowered head carriage and lethargy and subsequent progressive ataxia. Image was acquired with the patient standing. A collapsed intervertebral disk space at C7-T1 is evident, with sclerosis of the vertebral end plates and proliferative new bone at the ventral aspect of the vertebral bodies of C7 and T1.

and cranial bodies of C7 and T1, respectively (**Figure 2**), with a hypointensity of the adjacent bone tissue in all sequences. The extensive loss of normal osseous architecture and proliferation was highly suggestive of a septic process resulting in vertebral soft tissue and bone remodeling and spinal cord compression. Considering the signalment, clinical signs, and imaging findings, a degenerative disease process such as caudal cervical spondylomyelopathy was considered less likely. An 8-week course of antimicrobials (ceftiofur[j] [4.4 mg/kg {2 mg/lb}, IV, q 12 h] and florfenicol[k] [20 mg/kg, SC, q 24 h for 7 days, then q 48 h thereafter]) was initiated, and the patient was discharged. According to the referring veterinarian, the animal's degree of ataxia stabilized at grade I/IV to II/IV.[3]

Six months later, the alpaca was once again referred for evaluation because of further progressive ataxia (grade III/IV). The ataxia was marked in the pelvic limbs and moderate in the thoracic limbs. The alpaca continued to have reduced cervical movement and low head carriage. Repeated diagnostic imaging was performed under general anesthesia. The patient was premedicated with xylazine[e] (0.3 mg/kg [0.14 mg/lb], IV), followed by induction of anesthesia with ketamine[l] (2.2 mg/kg [1.0 mg/lb], IV) and midazolam[g] (0.1 mg/kg [0.045 mg/lb], IV). An endotracheal tube was then placed, and anesthesia was maintained with sevoflurane[h] in oxygen. Magnetic resonance imaging showed increased spinal cord compression (**Figure 3**) with further intervertebral disk collapse and displacement of the spinal cord to the right owing to lateral bone proliferation on the left of the vertebral canal. Computed tomographic evaluation[m] of the same region confirmed the presence of proliferative new bone and destruction of the normal osseous architecture of C7 and T1 with collapse of the intervertebral space (**Figure 4**).

Considering the deterioration in clinical signs and the imaging findings, immediate surgical treatment was elected during the same anesthetic episode. The alpaca was prepared for surgery. Ceftiofur[j] (2.2 mg/kg, IV, q 12 h) and flunixin meglumine[n] (1.1 mg/kg [0.5 mg/lb], IV, q 12 h) were initiated. The alpaca was placed in sternal recumbency with the head and neck extended, clipped, and aseptically prepared for surgery from the level of the first cervical vertebra to the seventh thoracic vertebra, 10 cm from either side of the dorsal midline. A longitudinal skin incision was made 2 cm left of the dorsal midline, from C4 to T3, on the basis of palpation of anatomic landmarks. The nuchal ligament was not separated longitudinally but reflected to the right of midline and in doing so separated from the dorsal aspect of the spinous processes. The approach was continued in the midline, separating the dorsal musculature and reflecting the musculature from the spinous processes of T1 and T2. The spinous process of T1 was removed to the level of the articular processes with Ruskin rongeurs,[o] providing a flat dorsal surface of the dorsal lamina.

Dorsal laminectomy was performed with a pneumatic drill[p] and 3-mm carbide burr, cooled by means of copious lavage of the surgery site with sterile fluids. A clear field of view was maintained with fluid suction and bone hemostasis.[q] Bone was removed in thin layers in a rectangular window with the articular processes used as lateral landmarks. The surface was monitored for pliability by palpation, and the final portion of the dorsal lamina was removed with Kerrison rongeurs[o] to avoid trauma to the underlying spinal cord. Because lateral compression of the spinal cord was identified on MRI, additional bone was removed from the axial aspect of the left vertebral pedicles of C7 and T1 with a 2-mm burr. Free dorsal expansion of the spinal cord was ensured by resection of the ligamentum flavum; the dura mater was tented with a spay hook and sharply incised. Prior to closure of the surgical site, bovine collagen sponge[r] was placed over the debrided area to minimize scar tissue formation. Muscle and subcutis were closed in a simple continuous suture pattern (2-0 polyglecaprone 25[s]), and the skin was closed in a cruciate suture pattern (size-1 nylon[s]). A cross-elastic adhesive dressing[t] was applied, and anesthetic recovery was uneventful. No external cervical support was provided postoperatively. During the recovery

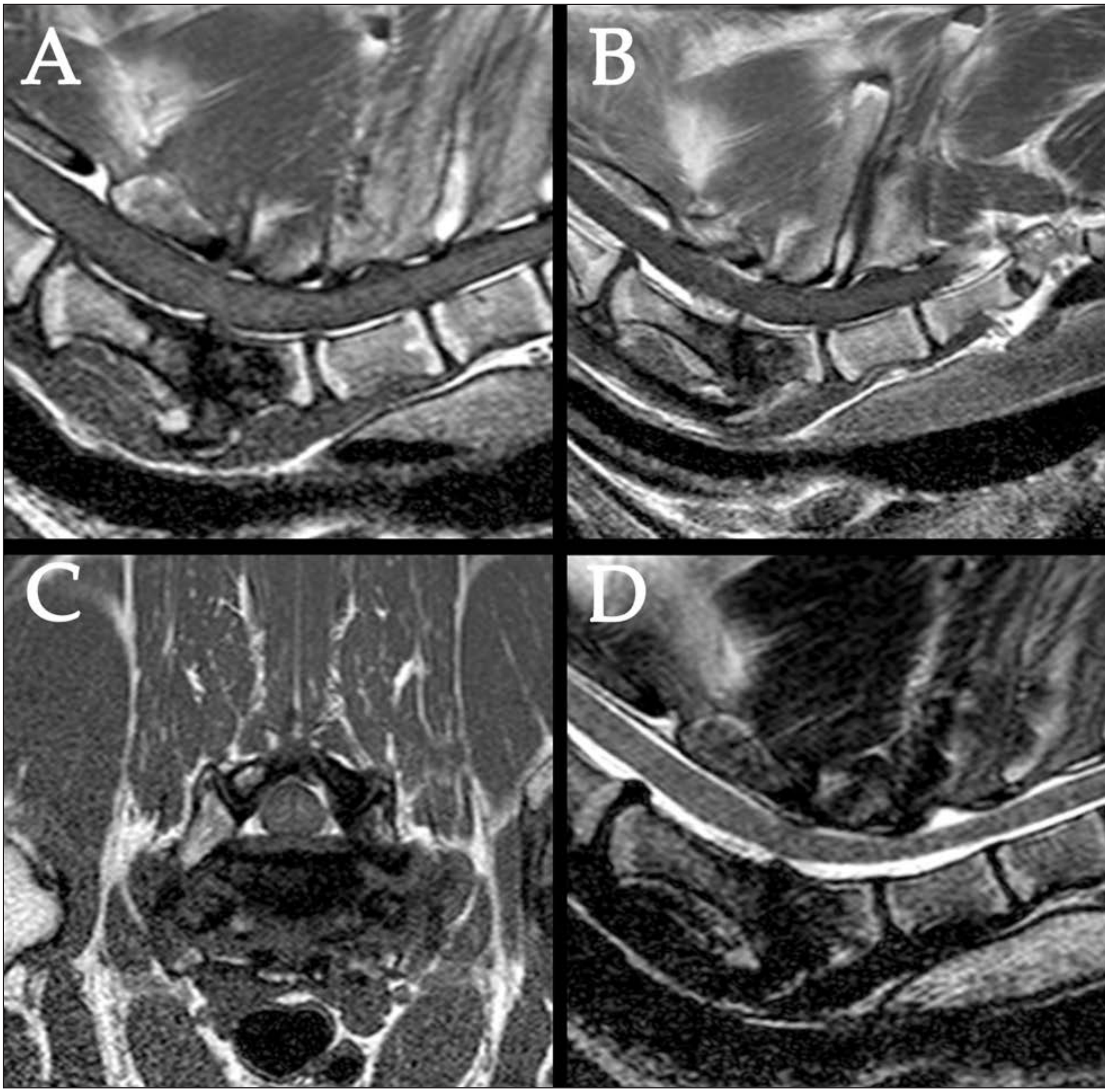

Figure 2—Magnetic resonance images of the caudal cervical vertebral region of the patient in Figure 1 performed 8 months after initial evaluation, after failure to respond to 2 weeks of medical treatment. The patient was under general anesthesia and positioned in lateral recumbency. A—Sagittal T1-weighted image. B—Sagittal T1-weighted postcontrast image. C—Transverse T1-weighted image. D—Sagittal T2-weighted image. The sagittal magnetic resonance images show extensive disruption of the normal architecture of the vertebral end plates of C7 and T1 with a hypointense signal, compared with the adjacent bony tissue for all sequences; collapse of the intervertebral space; and ventral new bone proliferation. On the transverse magnetic resonance image, the left articular facet processes appear hypointense and thickened, compared with the right.

period, the alpaca was assisted to stand. The degree of ataxia remained unchanged for the first 48 hours (grade III/IV) and then increased with further paresis and hypermetria in all 4 limbs. The animal needed help to stand but could remain standing unaided with a wide base stance. Subsequently, ataxia gradually improved, and at the time of discharge 7 days after admission and surgery, the level of ataxia was improved from admission (grade II/IV). Administration of flunixin was discontinued 5 days after surgery. Because of the chronicity of the primary lesion, treatment with ceftiofur[d] (2.2 mg/kg, IV, q 12 h) was continued for 8 weeks to ensure complete resolution of the septic process. Incisional healing was uncomplicated, and skin sutures were removed routinely 14 days after surgery. Repeated diagnostic imaging was not possible because of budgetary constraints.

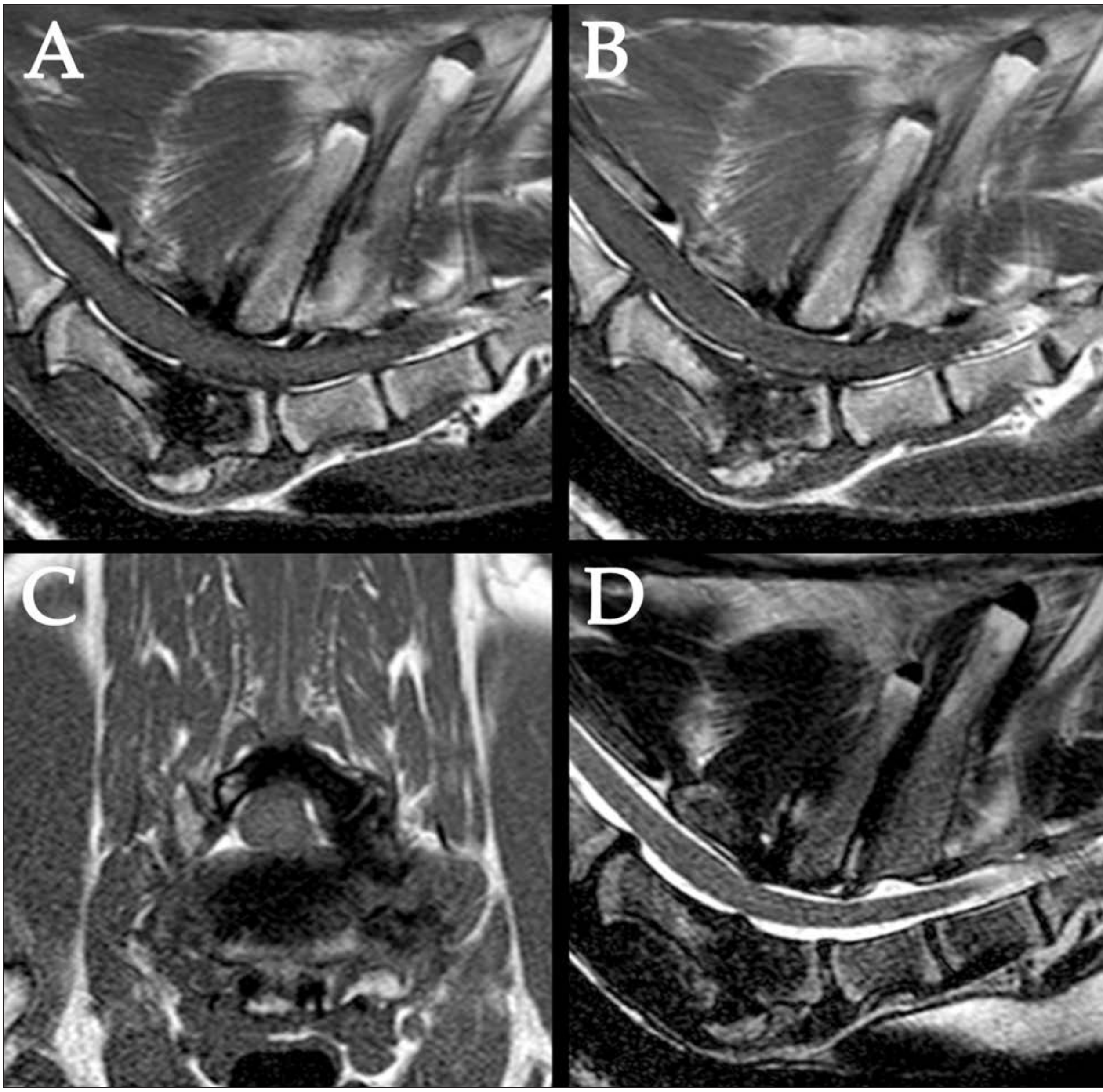

Figure 3—Magnetic resonance images of the caudal cervical vertebral region of the patient in Figure 1 obtained 14 months after initial evaluation. The patient was under general anesthesia and positioned in lateral recumbency. A—Sagittal T1-weighted image. B—Sagittal T1-weighted postcontrast image. C—Transverse T1-weighted image. D—Sagittal T2-weighted image. The sagittal magnetic resonance images show limited progression of the disruption of the vertebral end plates of C7 and T1, with a similar hypointense signal, compared with that of the adjacent bony tissue for all sequences; collapse of the intervertebral space; and ventral new bone proliferation. In contrast, the left articular facet processes appear thickened, causing a deviation of the spinal cord to the right. At the completion of diagnostic imaging, following repositioning in sternal recumbency and standard sterile preparation, the patient was treated for cervical stenotic myelopathy by means of dorsal laminectomy of C7 and T1.

The referring veterinarian and owner reported a gradual improvement in ataxia, allowing pasture turnout at 6 weeks after surgery and return to breeding activity at 15 weeks after surgery. Cervical mobility returned to normal. The ataxia improved considerably but had not completely resolved at the 6 month follow-up (grade I/IV). The target outcome of breeding soundness was achieved, with 6 of 7 hembra bred in the first year confirmed pregnant on ultrasonographic examination, producing 6 crias, and a further 4 crias in the second year. The alpaca was euthanized 28 months after surgery owing to progressive difficulty raising the head. There were also subjective signs of increased hind limb weakness with knuckling and slower proprioceptive reactions; however, it remained ambulatory, never becoming recumbent.

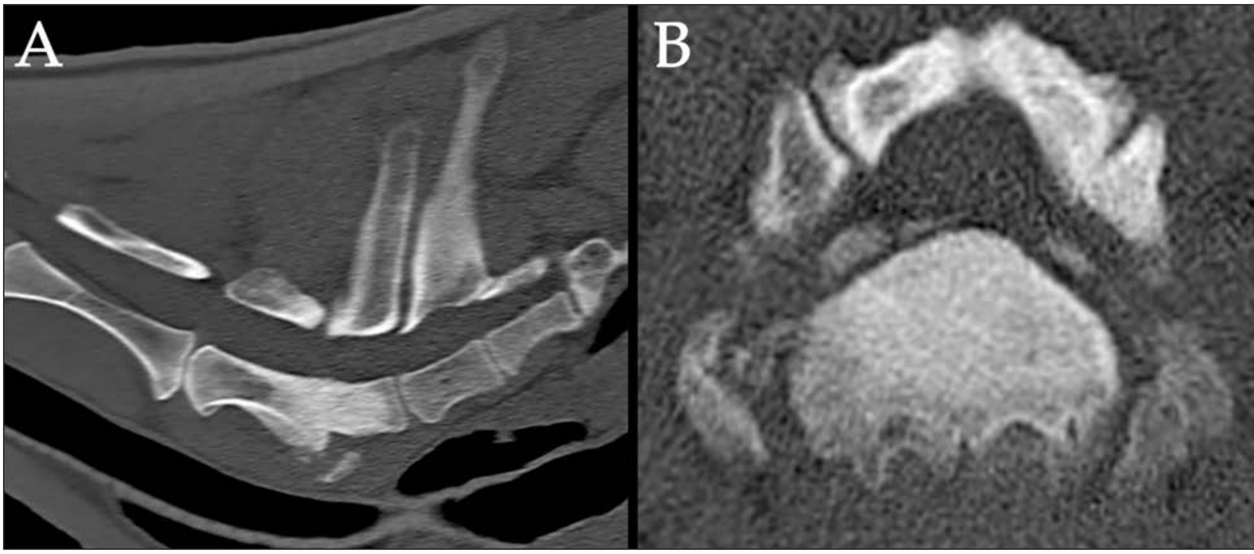

Figure 4—Computed tomographic images of the cervical vertebral region of the patient in Figure 1 obtained 14 months after initial evaluation and immediately prior to dorsal laminectomy. A—Sagittal CT reconstruction of the caudal cervical vertebral region showing marked remodeling of C7 and T1, with complete collapse of the intervertebral disk space, increased attenuation of the vertebral endplates, and possible fusion of the vertebral bodies. B—Transverse CT image at the level of C7-T1 showing an increased attenuation and size of the left articular processes and facet joint. There is new bone formation associated with the intervertebral disk, and ventrally, the intervertebral disk appears mottled with areas of radiolucency.

Discussion

In the present report, cervical stenotic myelopathy was treated successfully by means of dorsal laminectomy in a South American camelid. A good outcome with adequate alleviation of clinical signs and breeding soundness for > 2 years was achieved following surgery. We suggest that the most likely etiology in this patient was diskospondylitis; however, a degenerative disease process cannot be completely excluded. Early identification of diskospondylitis is critical: in human patients, if spinal cord compression results in paralysis for > 24 to 36 hours before treatment is initiated, neurologic function rarely returns.[4] Acute forms of diskospondylitis in humans, horses, and cattle have been managed medically with prompt antimicrobial treatment,[5–7] and this may have changed the clinical course of the case of the present report, if the condition had been identified and treated earlier.[8,9] With more advanced disease, bone and ligamentous remodeling has been described in humans and horses, resulting in spinal cord compression and potentially manifesting in neurologic deficits and reduced neck mobility, as was seen in this alpaca.[10,11] Following the poor response to medical management and the progression of ataxia, surgical management was elected in this case.

Prior to surgery, attempts to establish whether the lesion had a dynamic component were not performed. In dogs, there is ambiguity in the diagnosis of clinically important compression of the spinal cord on a myelogram following cervical flexion and extension, and the procedure is not without risk of neurologic decompensation.[12] An 11% to 16% reduction in cross-sectional area of the vertebral canal is expected during cervical extension in clinically normal humans because of soft tissue infolding.[13,14] Extension of the vertebral column has also been shown to increase the cross-sectional area of the spinal cord in sheep, dogs, and pigs.[15] Because of the risk of iatrogenic decompensation following cervical flexion and extension, traction became the technique of choice to differentiate dynamic from static lesions in dogs. But the latter has never been standardized, and comparing myelographic to MRI evaluations has shown the diagnostic technique to be highly subjective in dogs.[16] In horses, myelography may also be unreliable in localizing the site of spinal cord compression.[17,18]

Dorsal laminectomy was elected in this patient because osseous proliferation generally results in static compression, and direct decompression is recommended for similar lesions in dogs.[19,20] In the alpaca of the present report, dorsal laminectomy allowed the delicate debridement of proliferative new bone from the dorsolateral wall of the vertebral canal. Hemilaminectomy could have been performed in this patient; however, the approach is technically more complex, with limited opportunity for atraumatic dissection down facial planes. Also, we and others[20] believe that visualization is inferior to that for a dorsal laminectomy in dogs. In this caudal location, the cranial aspect of the scapula can also limit access to the C7-T1 articulation when a dorsolateral approach is used in dogs. Further, the dorsal laminectomy technique retains the majority of the articular facets, and stability is maintained.

Ventral decompression is routinely used in small animals to remove extruded intervertebral disk material that compresses the spinal cord.[21] In this alpaca, the compression was not only limited to the ventral aspect of the spinal cord but also the left lateral margin, and a ventral approach would not allow for dorsolateral decompression and subsequent mobility of the spinal cord in any direction. This technique would have also involved disrupting the potentially septic process within the vertebral bodies. Complications associated with ventral decompression in dogs include instability following extensive bone removal and penetration of the vertebral venous plexus.[22,23]

The surgical approach described for this alpaca was similar to that used in dogs and human patients and was associated with similar mild postoperative morbidity.[24–26] The dorsal laminectomy technique has been reported in horses but has high morbidity and a low success rate.[27,28] The procedure involves removing the dorsocaudal aspect of the cranial vertebra and the dorsocranial aspect of the caudal vertebra surrounding the area of compression. This technique has been successfully used for the removal of intramedullary or extramedullary masses or lesions, such as metastatic melanomas, hypertrophic dorsal laminae, and abscesses.[28] The procedure is made difficult if the horse is not positioned correctly, and currently the preferred positions are lateral recumbency and sternal recumbency.[28,u] The procedure is not widely used because of its complexity and the surgical time required as well as the risk of severe postoperative complications including articular fractures during recovery, compressive hematomas, and suppurative meningitis.[28,29,u] Unlike alpacas, the neck of horses is heavily muscled. It has been suggested that this results in large stresses on the remaining intact articular processes, causing fractures; therefore, judicious removal of the lamina is recommended.[28]

In light of the technical difficulties and morbidity and mortality rate associated with dorsal laminectomy in horses, vertebral stabilization is now routinely achieved with vertebral interbody fusion via a ventral approach with the horse placed in dorsal recumbency. This can be achieved by means of a purpose-made kerf-cut cylinder or a locking compression plate.[30,31,v] The kerf-cut cylinder requires custom equipment for implantation, which results in additional initial costs, and a recent comparative study[32] on cadaver cervical vertebrae suggests superior mechanical performance of a single 4.5-mm broad 8-hole locking compression, compared with the kerf-cut cylinder.

A calf with a spinal cord epidural abscess diagnosed by means of plain and contrast MRI was successfully treated with dorsal laminectomy.[33] The calf was positioned in sternal recumbency with the head and neck extended; a similar technique to that reported for the patient of this report was used to relieve spinal cord compression at C3-C4. The calf responded well and was growing at a normal rate with no neurologic deficits.[33]

Indirect decompression using vertebral distraction techniques, as described for dogs[34] and horses,[35–37] was considered; however, distraction and stabilization would not have immediately addressed the static compressive lesion in this patient. This technique would also have required placing implants into bone previously affected by a septic process, and complete resolution of the infection could not be confirmed at the time of surgery. There was no evidence of instability in our patient, and therefore we believed that distraction and stabilization were unnecessary.

It is our opinion that a dorsal laminectomy was an appropriate approach to treat the lesion at the C7-T1 articulation in the patient described in this report. Access to the dorsal aspect of the vertebrae was relatively straightforward despite the alpaca's anatomy, with slender spinous processes and relatively minimal musculature, compared with an affected adult horse. If the lesion had been at the C2-C3 articulation, the more substantial dorsal aspect to C2 and the insertion of the nuchal ligament would have made the approach more challenging, and a hemilaminectomy may have been more appropriate. At all other cervical articulations, we suggest that the anatomy would allow for a dorsal laminectomy to be performed for a similar disease process.

Following surgery, the degree of ataxia worsened in the short term before gradually improving. We have observed worsening ataxia in dogs undergoing dorsal laminectomy for caudal cervical spondylomyelopathy in our practice, and the same has been reported in the literature.[19] It has been suggested that the increase in ataxia is due to short-term instability in the vertebral column induced by surgery.[19] We question this theory and suggest that it is due to reperfusion injury following relief of a chronically compressed spinal cord. The mild ataxia (grade I/IV) observed 6 months after surgery was considered a success, as the alpaca could return to breeding soundness. Unlike in larger athletic animals, such as horses, where ataxia can result in stumbling and falling with subsequent injury to bystanders or riders, this grade of ataxia was subtle, and the alpaca was considered no risk to itself or to human safety. The outcome of surgery was considered successful for this patient because it was able to breed for 2 seasons, producing a total of 10 live crias over 2 years. Furthermore, the dorsal laminectomy enabled neurologic improvement such that the alpaca lived for over 2 years (28 months) after surgery while serving as a breeding animal. Euthanasia was eventually performed only when signs of neurologic deterioration affected quality of life (inability to raise the head as well as hind limb weakness, knuckling, and decreased proprioception). The owner was highly satisfied with the outcome of surgery.

Veterinarians treating camelids should be aware of the initial clinical signs and possible surgical treatment options for cervical vertebral stenotic myelopathy. In patients with acute clinical signs, the reduced cervical mobility and signs of pain on manipulation should prompt further investigation including appropriate diagnostic imaging. Patients that fail to respond to initial medical management may be candidates for surgical treatment.

a. Vetivex Solution for Infusion, Dechra Veterinary Products, Shrewsbury, Shropshire, England.
b. Engemycin 10% DD Solution for Injection, MSD Animal Health, Milton Keynes, Buckinghamshire, England.
c. Metacam, Boehringer Ingeheim Ltd, Bracknell, Berkshire, England.
d. Methadone HCL, Dechra Veterinary Products, Shrewsbury, Shropshire, England.
e. Chanazine 10, Chanelle Animal Health UK, Loughrea, Galway, Ireland.
f. Vetofol, 1% wt/vol, Norbrook Laboratories (GB) Ltd, Corby, Northamptonshire, England.
g. Hypnovel, 10 mg/2 mL, Roche Products Ltd (Pharmaceuticals), Welwyn Garden City, Hertfordshire, England.
h. Sevoflo, Abbott Animal Health, Maidenhead, Berkshire, England.
i. Achieva 1.5T A-series, Philips Healthcare, Best, The Netherlands.
j. Excenel, Pfizer Ltd, Sandwich, Kent, England.
k. Nuflor, MSD Animal Health, Milton Keynes, Buckinghamshire, England.

l. Ketamidor 100 mg/mL, Chanelle Animal Health UK, Loughrea, Galway, Ireland.
m. GE Lightspeed Pro scanner, GE Healthcare, Chalfont St Giles, Buckinghamshire, England.
n. Finadyne, Norbrook Laboratories Ltd, Newry, Down, Ireland.
o. Sontec Instruments, Centennial, Colo.
p. Surgairtome II, ConMed, Largo, Fla.
q. Bone Wax, Ethicon Inc, Johnson & Johnson Medical Ltd, Livingston, West Lothian, Scotland.
r. Lyostypt, B, Braun Melsungen AG Carl-Braun-Strabe, Melsungen, Germany.
s. Ethicon Inc, Johnson & Johnson Medical Ltd, Livingston, West Lothian, Scotland.
t. Animal Polster, Snogg AS, Kristiansand, Norway.
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