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Diagnosis and surgical removal of brain abscesses in a juvenile alpaca

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Case Description—A 1-month-old female alpaca was examined because of progressive clinical signs consistent with an intracranial lesion.

Clinical Findings—Clinical signs included signs of depression, lethargy, tetraparesis, and neck weakness. Two large isointense intracranial masses could be seen on T1-weighted magnetic resonance images. On T2-weighted images, the masses contained concentric rings of hypointense and hyperintense material.

Treatment and Outcome—2 abscesses were removed via a craniotomy that incorporated removal of the sagittal crest and surrounding skull and transection of the sagittal sinus. The bony deficit was replaced with polypropylene mesh. The alpaca recovered within 2 weeks and was fully integrated into the herd within 1 month after surgery.

Clinical Relevance—Findings indicated that surgical removal is a feasible means of successfully treating intracranial abscesses in juvenile alpacas. (*J Am Vet Med Assoc* 2007;231:1558–1561)

A 1-month-old female alpaca weighing 15 kg (33 lb) was brought to the Queen's Veterinary School hospital with a history of dullness, swaying, and head nodding that had become progressively worse over the previous week. The dam had been brought to the United Kingdom from Australia during the last month of pregnancy to join a herd of approximately 200. For 3 days following parturition, the cria was reportedly dull and maladjusted, but then became more responsive and suckled from the dam. Shortly after birth, the cria was given an injection of florfenicol-flunixin meglumine^a (80 mg/kg [36 mg/lb], IM) by the referring veterinarian because of concerns about possible low-grade peritonitis.

On initial examination, the cria remained in sternal recumbency with its head raised but swaying from side to side; signs of depression were evident. Rectal temperature was 37.3°C (99.1°F), pulse rate was 100 beats/min, and respiration rate was 32 breaths/min. Results of abdominal palpation and auscultation of the heart and lungs were unremarkable. The cria was reluctant to support its weight and had deficits in foot placement and hopping reactions in all 4 limbs. Flexor reflexes were normal in all 4 limbs, and strong patellar reflexes were present. Pupillary light reflexes and menace responses were normal. There was no evidence of pain associated with spinal palpation or manipulation. The abnormal mentation and involvement of all 4 limbs combined with an absence of cranial nerve deficits suggested a diffuse forebrain lesion or possible metabolic disorder.

Diagnostic testing included a serum biochemical panel, CBC, urinalysis, and measurement of baseline serum bile acids concentration. No clinically important abnormalities except mild neutrophilia (12.9×10^9 WBCs/L; reference range, 5.4 to 11.38×10^9 WBCs/L) were identified. Cerebrospinal fluid taken via lumbar puncture contained a normal protein concentration (0.41 g/L); no nucleated cells were seen.

Ceftiofur (2 mg/kg [0.9 mg/lb], SC, q 24 h) was administered because of the possibility of an infectious cause for the neutrophilia and diffuse forebrain signs. Neurologic deterioration continued over the following 4 days, to the point that the cria became unable to stand or maintain sternal recumbency and ceased to suckle. The cria became increasingly unresponsive to the environment, lying predominantly in right lateral recumbency while grinding its teeth. When lifted, the limbs and neck were flaccid, but when lying in lateral recumbency, the cria would occasionally thrust its limbs out in rigid extension. Elevation of the head induced vertical nystagmus. The progressive neurologic signs increased suspicion of a space-occupying forebrain lesion associated with early cerebellar herniation at the foramen magnum. Differential diagnoses that were considered included hydrocephalus, neoplasia, parasitic cyst, and abscess.

The cria was anesthetized with a combination of diazepam, ketamine, and sevoflurane, and magnetic resonance imaging of the head was performed with a 0.2T permanent magnet.^b Examination of sagittal and transverse T1-weighted images (repetition time, 800 milliseconds; echo time, 26 milliseconds) revealed a dome-shaped calvarium with caudoventral displacement of both cerebral hemispheres and compression of the lateral ventricles. The falx cerebri was deviated to the right, and there was apparent smoothing of the gyri in the left hemisphere with poor differentiation of white matter from gray matter, suggestive of a large, spheroid isointense mass in the left cerebral hemi-

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sphere (Figure 1). On transverse images, the mesencephalic aqueduct was displaced toward the right, and on sagittal images, the cerebellum was severely compressed rostrocaudally, with an indentation caudally, suggestive of a high pressure within the caudal fossa secondary to subtentorial herniation of the cerebral hemispheres. On T2-weighted images (repetition time, 3,000 milliseconds; echo time, 80 milliseconds), 2 masses could be seen. One was located rostradorsally on the right and was compressing the olfactory lobe. The other was larger and was overlying the left cerebral hemisphere. The bulk of the larger mass was heterogenous with an isointense centre surrounded by a large area of hypointensity. Surrounding the bulk of the mass was a hyperintense ring interior to a hypointense ring separating the mass from the normal-appearing brain. Most of the smaller mass was hypointense with a surrounding high-signal-intensity ring. Examination of fluid attenuated inversion recovery images did not reveal any differences in signal intensities of the lesions, but effectively highlighted the severe compression of the lateral ventricles. Examination of gadolinium-enhanced T1-weighted images revealed contrast-enhanced rings

around the 2 isointense masses. The imaging diagnosis was intracranial abscess formation.

Regular monitoring revealed a decrease in the cria's heart rate to 80 beats/min 5 hours after anesthetic recovery and deterioration of its neurologic status to a complete lack of awareness of the surrounding environment. These findings, in combination with the poor response to antimicrobial treatment and the dorsal location of the 2 masses, allowing straightforward surgical access, prompted immediate craniotomy.

The cria was again anesthetized with a combination of diazepam, propofol, and sevoflurane and positioned in sternal recumbency with its head elevated. A midline skin incision exposed the underlying calvarium, which was extremely thin with complete deficits in some places, making it impossible to create a bone flap for later replacement. Thus, Rongeur forceps were used to remove the bone and expose the larger of the 2 masses seen on magnetic resonance images. A 20-gauge spinal needle was inserted into the mass, and a small plug of thick, white caseous material was removed from within the bore of the needle, confirming that the mass was an abscess. However, it was not possible to remove

the contents by aspiration. Therefore, the craniotomy site was expanded with the aim of total excision of the abscess and surrounding capsule. The sagittal crest was removed and the sagittal sinus transected. Bleeding from the sagittal sinus remained a persistent problem until sufficient access was gained to apply bipolar diathermy directly to the vessel; hemostasis, in the meantime, was achieved by use of surgical cellulose.^c Incision of the dura exposed the surface of the abscess. The capsule of the abscess was dissected away from normal brain tissue to permit complete excision. During this procedure, the capsule tore at the site of the previous needle puncture, revealing thick, creamy caseous material. Some of this material was removed to ease manipulation of the capsule and reduce the potential for contamination. Samples were submitted for bacteriologic culture and susceptibility testing, and treatment with amoxicillin-clavulanate (20 mg/kg [9 mg/lb], IV, q 6 h) and metronidazole (15 mg/kg [6.8 mg/lb], IV, q 8 h) was begun. The craniotomy site was extended further rostrally on the right side to expose the second abscess, which was excised in its entirety with the capsule. The extensive incision of the dura mater that was required for removal of the 2 abscesses involved incising through the falx cerebri so that the cerebral hemispheres were no longer suspended from the arch of the cranial vault and sank ventrally. After irrigation of the cranial cavity, the calvarium deficit was covered with polypropylene mesh sutured to the remaining bone with 2-0 polypropylene. The subcutaneous tissue

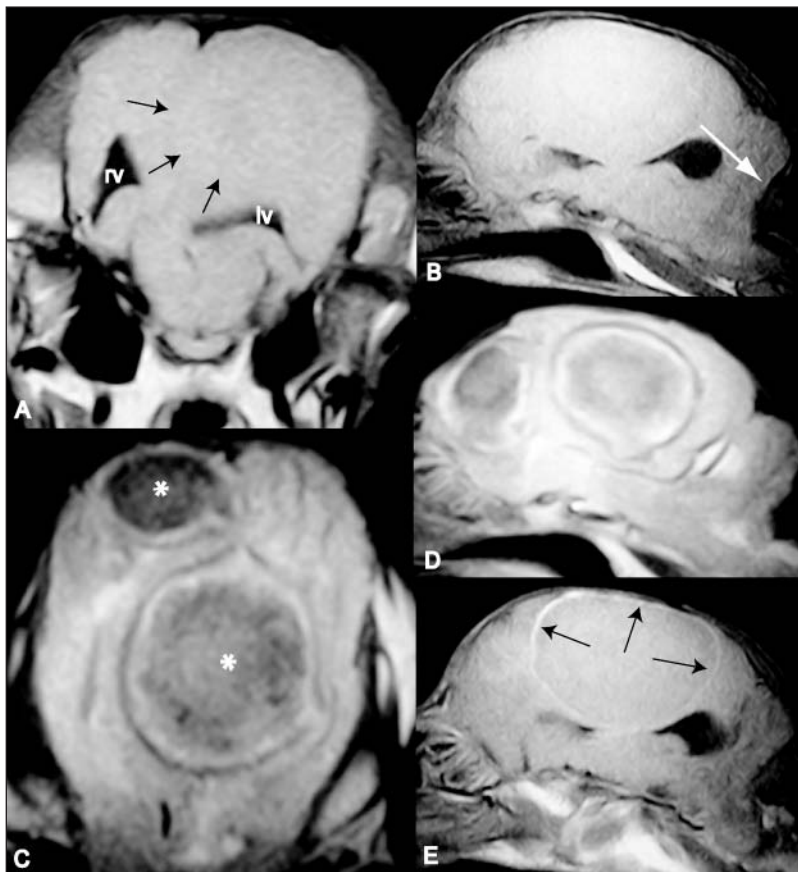


Figure 1—Magnetic resonance images of a 1-month-old female alpaca with 2 brain abscesses. A—Transverse T1-weighted image showing compression of the right (rv) and left lateral ventricles (lv) by an isointense mass (arrows). B—Sagittal T1-weighted image showing dome-shaped calvarium and compression of the cerebellum (arrow). C—Dorsal T2-weighted image showing 2 hypointense masses (*) each with a hyperintense surrounding ring. The larger mass also has a second outer hypointense ring. D—Sagittal T2-weighted image with similar findings to C. Note the size and position of the 2 masses and severe compression of the cerebellum. E—Sagittal T1-weighted image after IV administration of gadolinium revealing ring enhancement of the larger mass (arrows).

and skin were closed routinely, and a stent bandage was applied to the skin incision. Because of low blood pressure caused by blood loss from the sagittal sinus, 2 boluses (14 mL and 6 mL) of succinylated gelatin colloid^d were administered during surgery and a constant-rate infusion (2 mL/kg/h) was administered for 90 minutes. After surgery, a transfusion of 260 mL of whole blood from the dam was given.

Forty-eight hours after surgery, the cria was pyrexia (40.0°C [104°F]). A CBC and serum biochemical testing revealed neutrophilia (28.6 × 10⁹ neutrophils/L; reference range, 5.4 to 11.38 neutrophils/L) and hyperfibrinogenemia (6 g/L; reference range, 1 to 4 g/L) consistent with inflammation. Bacteriologic culture of samples obtained during surgery yielded *Fusiformes* spp susceptible to amoxicillin and metronidazole. Therefore, antimicrobial treatment was continued as before for an additional 7 days. Flunixin (1 mg/kg [0.45 mg/lb], IV, q 8 h) was administered for 5 days for pain relief.

The cria's neurologic status gradually improved over the following 10 days. Immediately after surgery, the animal was responsive and could maintain sternal recumbency with its head raised. However, it was unable to stand or suckle and was fed via a nasogastric tube. Five days after surgery, the cria could walk with sling support, but struggled to stand unaided. One week after surgery, the cria started to suck milk from a bottle and could walk unaided with hobbles on its pelvic limbs. Ultrasonography of the liver, spleen, kidneys, bladder, umbilicus, and heart did not reveal any abnormalities or any source of infection. Ultrasonography through the cranial deficit revealed fluid accumulation dorsal to the brain; the gyri appeared regular, and the ventricles were in a normal position, suggesting that the brain had partially returned to its normal morphology.

Twelve days after surgery, the cria was able to stand, walk, suckle from the dam, and graze grass unaided and was discharged from the hospital. One month after surgery, the cria was fully integrated into the herd and was behaving and feeding normally.

Discussion

Brain abscesses occur commonly in newborn farm animals.^{1,2} Seeding of bacteria in the brain is thought to occur by extension from a primary infectious disease process involving the head (eg, cranial sinuses, nasal passages, middle ear, or head wound), via hematogenous spread from other organs, or as a result of systemic infection.²⁻⁴ However, it is not always possible to identify the infectious cause.^{2,5} In the cria described in the present report, no focus of infection was identified, but possible causes of the brain abscesses included hematogenous spread from the dam in utero and neonatal septicemia secondary to failure of passive transfer of immunity.⁶

Magnetic resonance images for the case described in the present report were strongly suggestive of a diagnosis of brain abscess.^{1,7} Typically, mature abscesses have an isointense to hypointense core on T1-weighted images and an isointense to hyperintense core with a hypointense capsule on T2-weighted images. Abscesses containing semisolid material tend to be isointense,⁷ which was the case for the abscesses in this cria. For-

mation of a capsule with accompanying neovascularization accounts for the ring enhancement of the lesion on T1-weighted images after administration of contrast medium. The 2 abscesses in this case may have been at different stages of development, as the smaller one had a much less clearly defined capsule without the surrounding hypointense ring associated with previously reported brain abscesses.

Abscesses are generally thought to not be accessible to drugs because of the connective tissue barrier on the outside and the necrotic (avascular) core.² In previous reports⁵⁻⁹ of animals with intracranial abscesses, treatment with antimicrobials alone has been unsuccessful, even when antimicrobials with excellent tissue penetration have been used. The use of magnetic resonance imaging has enhanced the ability to diagnose and accurately localize intracranial abscesses prior to drainage or excision.⁷ Initially, excision was the treatment of choice for intracranial abscesses, but this has now largely been replaced with stereotactic aspiration,³ whereby a needle or catheter is inserted via a craniotomy into the abscess for drainage. A similar approach has been used to successfully treat intracranial abscesses in horses.^{3,10}

In the case described in the present report, antimicrobial treatment alone was inadequate, as evidenced by the deterioration in clinical condition during treatment with ceftiofur. The fusiform bacteria isolated from the abscess were susceptible to cephalosporins, so ceftiofur should have been a suitable antimicrobial. Aspiration of the abscess was not possible because of the inspissated contents.

To our knowledge, this is the first report of successful excision of a brain abscess in an animal. The challenge was creating a large enough craniotomy site for removal. Incising the sagittal sinus is controversial because early reports¹¹ on craniotomy in dogs suggested this procedure was associated with a high mortality rate. Anecdotally, however, veterinary neurosurgeons have known for some time that death is not inevitable after ligation of the sagittal sinus in dogs, and findings in the present case demonstrate that the sagittal sinus can be safely ligated in alpacas also. During surgery, we were concerned about the possible negative effects of incising the falx cerebri, as excessive head movement following surgery could have allowed unrestrained movement of the brain within the skull, causing severe laceration. It is possible that the accumulation of fluid above the brain, as documented ultrasonographically, may have been sufficient to support the brain during the immediate postsurgical period. Our third concern was replacement of the calvarium. In small animals, a deficit is often left unfilled following intracranial surgery, but these deficits are usually much smaller and unilateral. In the case of the alpaca described in the present report, the large midline deficit in the calvarium would have left the brain susceptible to external trauma. The aim of the polypropylene mesh was to offer some initial protection and to provide a framework for fibrous or osseous material to form.

In summary, we conclude that magnetic resonance imaging can successfully be used to diagnose and localize intracranial abscesses in alpacas and that surgical removal is a feasible means of successfully treating intracranial abscesses in juvenile alpacas.

- Resflor, Schering-Plough Animal Health, Harefield, Uxbridge, Middlesex, England.
- Vet MRI, Esaote, via Siffali, Genova, Italy.
- Surgicel, Johnson & Johnson Medical Ltd, Gargrave, North Yorkshire, England.
- Gelofusine, Braun Medical Ltd, Thorncliffe Park, Sheffield, England.

References

- Seiler G, Cizinauskas S, Scheidegger J, et al. Low-field magnetic resonance imaging of a pyocephalus and a suspected brain abscess in a German Shepherd Dog. *Vet Radiol Ultrasound* 2001;42:417–422.
- Amand W, De Lahunta A, Ansley J, et al. Brain abscess in a Barbados sheep. *J Am Vet Med Assoc* 1973;163:562–564.
- Smith JJ, Provost PJ, Paradis MR. Bacterial meningitis and brain abscesses secondary to infectious disease processes involving the head in horses: seven cases (1980–2001). *J Am Vet Med Assoc* 2004;224:739–742.
- Cornelisse CJ, Schott HC II, Lowrie CT, et al. Successful treatment of intracranial abscesses in 2 horses. *J Vet Intern Med* 2001;15:494–500.
- Blood DC, Saunders LZ. Cerebral abscess in a calf. *Cornell Vet* 1950;40:336–345.
- Frank N, Couetil LL, Clarke KA. *Listeria monocytogenes* and *Escherichia coli* septicaemia and meningoencephalitis in a 7 day old llama. *Can Vet J* 1998;39:100–102.
- Audigie F, Tapprest J, George C, et al. Magnetic resonance imaging of a brain abscess in a 10-month-old filly. *Vet Radiol Ultrasound* 2004;45:210–215.
- Tsur I, Harmelin A, Dvir I, et al. Meningoencephalitis and brain abscessation due to *Escherichia coli* in a 2 week old alpaca cria. *Aust Vet J* 1996;74:437–438.
- Glass EN, De Lahunta A, Jackson C. Brain abscess in a goat. *Cornell Vet* 1993;83:275–282.
- Allen JR, Barbee DD, Boulton CR, et al. Brain abscess in a horse: diagnosis by computed tomography and successful surgical treatment. *Equine Vet J* 1987;19:552–555.
- Oliver JE Jr. Surgical approaches to the canine brain. *Am J Vet Res* 1968;29:353–378.



Selected abstract for JAVMA readers from the American Journal of Veterinary Research

Effect of show jumping training on the development of locomotory muscle in young horses
Nancy J. Rietbroek et al

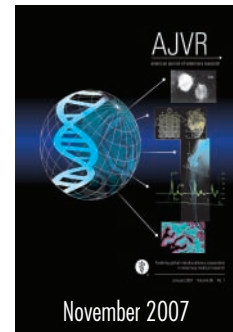
Objective—To investigate whether training for show jumping that is commenced early after birth affects the characteristics of equine locomotory muscle.

Animals—19 Dutch Warmblood horses.

Procedures—Horses were assigned to a trained or not trained (control) group. After weaning, training (free jumping [2 d/wk] that was alternated with a 20-minute period of exercise in a mechanical rotating walker [3 d/wk]) was started and continued until horses were 3 years old. Fiber type composition (determined from myosin heavy chain [MyHC] content), fiber area, diffusion index (area supplied by 1 capillary), citrate synthase activity, and Na⁺,K⁺-ATPase content were assessed in gluteus medius muscle specimens collected at 0.5, 1, 2, and 3 years.

Results—Developmental changes included an increase in MyHC fiber type IIa and a decrease in type IIad; increases in fiber area, diffusion index, and citrate synthase activity; and a decrease in Na⁺,K⁺-ATPase content. The MyHC fiber type I and type IIcd were detected in high and low proportions, respectively. Training increased Na⁺,K⁺-ATPase content, but did not affect other variables.

Conclusions and Clinical Relevance—In horses, show jumping training at an early age resulted in increased Na⁺,K⁺-ATPase content of the deep portions of the gluteus medius muscle. The lack of training effects on the other muscle characteristics can partly be explained by the fact that an appropriate (aerobic) fiber type composition was already established at training commencement. These data also suggested that the developmental changes in equine muscle represent sufficient adaptation to meet the demands of this specific training. (*Am J Vet Res* 2007;68:1232–1238)



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