Pneumocephalus secondary to removal of an osteoma from the paranasal sinuses of a horse

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Case Description—A 2-year-old Quarter Horse was evaluated because of a progressive left-sided facial deformity and unilateral nasal and ocular discharge.

Clinical Findings—Physical examination revealed convexity of the left frontonasal region, left-sided nasal and ocular discharge, and decreased air flow through the left nares. Radiography and computed tomography revealed an extensively mineralized mass occupying most of the left paranasal sinuses.

Treatment and Outcome—The mass was surgically debulked, but complete removal was precluded because the mass was tightly adhered to the frontal and maxillary bones. Results of histologic examination of the mass were consistent with a diagnosis of osteoma. The horse developed transient pyrexia and colic following surgery, and postoperative radiography revealed gas opacities in the lateral ventricles of the brain, consistent with iatrogenic pneumocephalus. However, the horse did not develop any neurologic signs and was performing normally 2 years after surgery.

Clinical Relevance—Findings reinforce concerns that paranasal sinus surgery in horses can be associated with intracranial complications such as pneumocephalus. In horses with a mass involving the paranasal sinuses, computed tomography may be helpful in determining the boundaries of the mass and formulating a surgical treatment plan. (J Am Vet Med Assoc 2009;235:184–188)

A 2-year-old 443-kg (975-lb) Quarter Horse stallion was admitted to the Washington State University Veterinary Teaching Hospital because of progressive left-sided facial deformity and unilateral nasal and ocular discharge. The left ocular discharge had been present ever since the horse had been acquired 7 months previously. The left nasal discharge developed shortly afterward and had been unresponsive to antimicrobial treatment. The left-sided facial deformity had first been noticed 2 months prior to admission, and upon examination, the left frontal bone protruded 2 to 3 cm in 1 area. A radiopaque mass involving the left paranasal sinuses was evident on radiographs obtained by the referring veterinarian.

On initial examination at Washington State University, the horse was in good body condition. Physical abnormalities that were identified included convexity in the area of the left paranasal sinuses, inspiratory stridor, labored breathing, an absence of air flow through the left nostril, mucopurulent discharge from the left nostril, and serous discharge from the medial canthus of the left eye. Percussion over the left and right frontal and maxillary sinuses revealed pronounced dullness on the left side but did not elicit signs of pain.

Computed tomography of the skull was performed to determine the extent of the mass and assist in surgical planning. Because of the horse’s dyspnea, the endotracheal tube was left in place during recovery from anesthesia until the patient was able to stand, at which time the endotracheal tube was removed and 2 intranasal tubes were inserted. The following day, the intranasal tubes were removed and a tracheostomy was performed.

On computed tomographic images, a multilobulated, extensively mineralized mass could be seen occupying the left conchofrontal sinus, the rostral and caudal compartments of the left maxillary sinus, and a portion of the right conchofrontal sinus and extending into the left nasal cavity and nasopharynx. The mass was causing rightward deviation of the nasal septum and distortion of the ethmoturbinates. Osteolysis of the bones of the skull was not present. Osseous changes included resorption of the alveolar bone of the left maxillary third molar (Figure 1). Mineral density of the mass was most consistent with an osteoma. Other differential diagnoses that were considered included compound odontoma, ameloblastoma, ameloblastic odontoma, and ossifying fibroma.

Surgical removal of the paranasal mass was recommended. The horse was anesthetized and positioned in right lateral recumbency, and a large frontonasal bone flap was created, as described.1 The mass was found to be occupying the entire left conchofrontal sinus and left

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maxillary sinus; the dorsal portion of the mass was solidly attached to underlying bone.

A high-speed drill and 6-mm ball drill bit were used to divide the mass, and fragments were removed with rongeurs. Because of the lack of a clear demarcation between the mass and calvarium, complete removal was not possible, and only as much of the mass was removed as was deemed prudent. Hemostasis was achieved through direct pressure and the use of chilled sterile saline (0.9% NaCl) solution. Prior to closure of the bone flap, the sinuses were thoroughly lavaged with copious amounts of chilled sterile saline solution.

A Chambers mare catheter was passed up the left nostril and used to withdraw the ends of two 6-inch gauze rolls that had been joined together and used to pack the sinuses. The rostral end of each gauze roll was sutured to the nasal diverticulum. The surgical incision was apposed, and the horse recovered from anesthesia without complications with the tracheostomy tube in place.

On gross examination, the mass consisted of 3 major sections partially covered by connective tissue. A dense, bone-like structure was evident in those areas where the surface of the mass had been removed with the drill. On histologic examination, most of the mass consisted of dense, well-differentiated compact bone with tightly packed lamellar Haversian systems. Findings were consistent with a diagnosis of osteoma.

Cefazolin sodium (10 mg/kg [4.5 mg/lb], IV, q 6 h), gentamicin sulfate (4.4 mg/kg [2 mg/lb], IV, q 24 h), and flunixin meglumine (1.1 mg/kg [0.5 mg/lb], IV, q 12 h) were administered beginning immediately prior to surgery and continuing for 9 days after surgery. Tri-methoprim-sulfamethoxazole (20 mg/kg [9 mg/lb], PO, q 12 h), metronidazole (15 mg/kg [6.8 mg/lb], PO, q 8 h), and phenylbutazone (2.2 mg/kg [1.0 mg/lb], PO, q 8 h) were then administered for an additional 10 days.

During the first night following surgery, the horse was found rolling in its stall and sweating. Heart rate (80 beats/min), respiratory rate (32 breaths/min), and rectal temperature (39.9°C [103.8°F]) were high; mucous membranes were pale; capillary refill time was < 2 seconds; and increased intestinal motility was evident during auscultation of all 4 abdominal quadrants. The horse was walked for 10 minutes, and flunixin meglumine (1.1 mg/kg, IV, once) was administered. The following morning, the horse had signs of depression and was coughing frequently. Heart rate was 44 beats/min, respiratory rate was 24 breaths/min, and rectal temperature was 39.3°C (102.8°F). Rectal temperature was within reference limits by the evening after surgery, and the cough resolved within 2 days after surgery.

The sinus packing was removed on the third day after surgery, and the tracheostomy tube was removed on the fifth day after surgery. On a lateral radiographic projection of the head obtained 6 days after surgery with the horse standing, remnant mineralized material could still be seen in the conchofrontal sinus. Two semicircular gas opacities superimposed on each other were evident in the cranial cavity. On lateral and dorsoventral radiographic projections obtained 8 days after surgery, the 2 semicircular gas opacities could still be seen (Figure 2) and were suspected to be pockets of air within the lateral ventricles of the brain. On a lateral radiographic projection obtained with the head elevated, the gas opacities were more drop-shaped than round (Figure 3), confirming the diagnosis of pneumocephalus.

The horse did not have any evidence of neurologic deficits while hospitalized. The volume of discharge from the left nostril decreased progressively during the first several days after surgery, and air flow through the left nostril increased substantially during this period, especially between 5 and 12 days after surgery.

The horse was discharged 12 days after surgery. During a follow-up telephone conversation 2 months...
Findings in the horse described in the present report reinforce concerns that paranasal sinus surgery in horses can be associated with intracranial complications such as pneumocephalus. In horses with a mass involving the paranasal sinuses, computed tomography may be helpful in determining the boundaries of the mass and formulating a surgical treatment plan.

In horses, paranasal sinus osteomas typically are rare, benign, slow-growing tumors; they are most common in young horses. The paranasal sinuses of the horse are diverticula of the nasal cavity and include the maxillary, frontal, and sphenoidal sinuses. The frontal sinus communicates extensively with the dorsal conchial sinus and together they form the conchofrontal sinus, which communicates with the caudal maxillary sinus through the frontomaxillary opening.

To our knowledge, this is the first report of intracranial pneumocephalus in a horse. Pneumocephalus is the intracranial accumulation of air and may occur when a communication exists between the intracranial and extracranial spaces. The condition is classified according to the location of the air as epidural, subdural, subarachnoid, intracerebral, or intraventricular. Spontaneous pneumocephalus associated with erosion of the posterior wall of the frontal sinus by an osteoma is a rare occurrence in people and in most affected people, pneumocephalus is a result of trauma, other sinonasal neoplasms, or craniotomy and sinus surgery. Other reported causes of pneumocephalus in people include fungal sinusitis, traumatic nasogastric intubation, epidural anesthesia, and meningitis. Subarachnoid pneumocephalus has previously been reported in a horse in which a traumatic injury caused a communication between the fractured presphenoid bone and the sphenopalatine sinus. Intraventricular pneumocephalus secondary to transfrontal craniotomy has been reported in 2 dogs, both of these dogs developed neurologic abnormalities typical of tension pneumocephalus, including seizures, ataxia, postural reaction deficits in all 4 limbs, and ophthalmic and other cranial nerve deficits. Unilateral CSF rhinorrhea was present in one of the dogs.

Because pneumocephalus is not usually associated with clinical signs in people and because mild transient neurologic deficits may not be noticed, the problem usually remains unrecognized unless diagnostic imaging is performed for unrelated reasons. Radiography, computed tomography, and magnetic resonance imaging are equally useful for confirming a diagnosis of pneumocephalus. In the present case, pneumocephalus was identified as an incidental finding on radiographs obtained after surgery to assess the extent of mass removal, as baseline measurements of the region were desired in the event that the osteoma recurred.

Even though the intracranial accumulation of air may not initially cause clinical signs, pneumocephalus has been associated with an increased risk of high intracranial pressures or bacterial meningitis. In people, treatment of pneumocephalus depends on the degree of intracranial pressure, the nature and severity of associated clinical signs, and the underlying cause. In individuals with pneumocephalus secondary to trauma or surgery, rest and close monitoring may be sufficient. In other individuals, needle aspiration or exploratory surgery and repair of the defect may be necessary. Some patients with CSF leakage may recover without specific treatment because a blood clot, edema, bone fragment, or prolapsed brain may temporarily or permanently occlude the dural lesion. In the horse described in the present report, neurologic deficits were not detected, suggesting that tension pneumocephalus did not occur. Nontension pneumocephalus in people is usually asymptomatic. There is a possibility that tension pneumocephalus did not develop in this horse because of a communication between the olfactory ventricle and the frontal sinus, which could have prevented excessive pressure from developing within the cerebral ventricles.

Two main hypotheses have been proposed to explain how the entry of air into the cranial cavity may be facilitated in patients with pneumocephalus. One suggests that development of a ball-valve mechanism allows air to enter the cranium through a fistula, especially when extracranial pressure exceeds intracranial pressure, such as during coughing or sneezing. The other proposes that air enters the cranium to compensate for negative pressure associated with leakage of CSF. It has been suggested that tracheostomy may be useful in individuals in which tension or recurrent pneumocephalus is associated with a ball-valve mechanism, as this may prevent high upper airway pressures. In the horse described in the present report, a tracheostomy tube was in place during and for 5 days after surgery.

Several factors increase the risk that a CSF fistula may occur, including preexisting cranial bone defects.
and surgical removal of tumors when cranial surgical landmarks have been obliterated by the pathologic process. Ideally, the location and extent of sinonasal tumors should be determined by means of computed tomography or magnetic resonance imaging before surgical intervention is attempted. In addition, in people, the incidence of skull base defects and CSF leakage following endoscopic sinus surgery is higher when power instruments, especially a power shaver, are used than when they are not used. Because of the weight of these instruments and their vibration, tactile feedback during use is less than optimal, and inadvertent damage to cranial and dural structures is more difficult to avoid.

In people, the region of the CNS most vulnerable to dural injury is the medial aspect of the anterior fontanelle ethmoidalis. This structure forms the lateral wall of the olfactory groove, close to where the anterior ethmoidal neurovascular bundle enters the anterior cranial fossa. The olfactory bulb contains a diverticulum from the rostral horn of the lateral ventricle that is called the ventricle of the olfactory bulb. It has been reported that the olfactory bulbs are more developed in stallions than in mares or geldings, and if so, it is possible that stallions may be predisposed to lesions in this area.

In the horse described in the present report, even though the tumor did not invade the cranial cavity, it is possible that pneumocephalus could have resulted from erosion of the skull base by the osteoma, as has been reported for people. However, the tumor had obliterated surgical landmarks, making surgical removal difficult, and it is more likely that pneumocephalus was iatrogenic. If a dural defect or CSF leak occurred during surgery, then abdominal straining during anesthetization or postsurgical coughing could have created negative intraventricular pressures that facilitated the entry of air into the ventricles.

Whenever space-occupying masses of the frontal sinuses or ethmoid labyrinth are surgically ablated, it is important to closely examine the cribiform plate for defects. Intraoperative detection of calvarial defects is sometimes possible with fluoroscopy. Another method commonly used for detecting dural defects is lumbar intrathecal injection of freshly prepared 5% sodium fluorescein dye, with migration of the dye traced endoscopically or by direct visualization. However, neurologic abnormalities have been reported to occur with this method in dogs. Computed tomography and magnetic resonance imaging have also been used to detect contrast medium passing through defects in the skull. Because the horse in the present report did not have any neurologic deficits or obvious CSF rhinorrhea, we opted to not perform invasive diagnostic procedures or examinations that would have required general anesthesia.

Several noninvasive methods have been proposed for detecting CSF leakage, including testing suspect fluids with reagent sticks used for measuring glucose concentration, the β-2 transferrin test, and the β-trace protein test. As a precaution, sanguineous discharge from the left nostril of the horse described in the present report was tested with a glucose reagent stick. Results were inconclusive, but whether this was because only a small quantity of nasal fluid was available for testing or because of heavy contamination with blood and mucus could not be determined.

It has been reported that approximately 90% of CSF leaks close spontaneously within 7 to 10 days, although the remaining 10% may persist for a month or more. A major concern in patients with CSF rhinorrhea is an increased risk of meningitis or intracranial sepsis. Thus, some authors have recommended prophylactic antimicrobial administration in patients with CSF leaks, although most experts now discourage this practice.

Intracranial injury is a reported complication of sinus surgery in people, although the neurologic sequelae may be subtle and go unrecognized during the postoperative period, with some patients experiencing only a persistent headache. We suggest that the transient episode of colic that occurred after surgery in the horse described in the present report may have been a result of postoperative pain. The horse had a brief febrile episode 10 hours after surgery that resolved within 12 hours. In humans, intraventricular hemorrhage has been reported to be a potential cause of fever, and the association between subarachnoid hemorrhage and fever has been well established.

### References


