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Review of Anatomy and Surgery of the Paranasal Sinuses of Horses

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Take Home Message

The complexity and vascularity of the sinuses makes surgical treatment of horses affected by disease of paranasal sinuses difficult. Performing surgery of the paranasal sinuses with the horse sedated and standing, rather than anesthetized and recumbent, eliminates the risks of general anesthesia, decreases expense, and simplifies the surgery by reducing hemorrhage.

Introduction

The clinician should have good knowledge of the anatomy of the equine paranasal sinuses to diagnose and treat horses for disease of the paranasal sinuses. The clinician must be able to create a frontonasal or maxillary osteoplastic flap to treat many horses for disease of the sinuses because many diseases of the sinuses can be resolved only by surgery.

Anatomy of the Paranasal Sinuses

The paired paranasal sinuses of the horse include the frontal, conchal (dorsal, middle, and ventral), rostral and caudal maxillary, and sphenopalatine sinuses. All of the sinuses of one side of the head communicate directly or indirectly with the middle nasal meatus through the nasomaxillary aperture. The rostromedial aspect of the frontal sinus communicates so freely with the dorsal conchal sinus that the two are referred to together as the conchofrontal sinus. The conchofrontal sinus joins the caudal maxillary sinus through the frontomaxillary aperture. The caudal limit of the conchofrontal sinuses is at the level of an imaginary line through the supraorbital foramen, and the rostral limit is at the level of an imaginary line perpendicular to the facial crest, halfway between the infraorbital foramen and the medial canthus of the eye. The rostral limits can also be found by passing the thumb and index finger caudally along the nasal bones until the digits begin to diverge from each other.

In addition to the dorsal conchal sinus, the horse also has middle and ventral conchal sinuses. The small, middle conchal sinus is located medial to the caudodorsal part of the caudal maxillary sinus with which it communicates. The more rostrally located ventral conchal sinus is continuous dorsally with the rostral maxillary sinus medial to the infraorbital canal.

The rostral and caudal maxillary sinuses are separated by a bony septum, the maxillary septum, which is usually located at the level of the 2nd maxillary molar. The rostral and caudal maxillary sinuses communicate with the middle nasal meatus through the shared, slit-like nasomaxillary aperture. The rostral maxillary sinus invaginates the maxilla, and the larger, caudal maxillary sinus invaginates the maxilla, lacrimal, zygomatic, and ethmoid bones. The
rostral limit of the maxillary sinuses is a line drawn from the rostral extremity of the facial crest to the infraorbital foramen, and the dorsal limit is a line drawn from the medial canthus of the eye to the infraorbital foramen. The ventral limit is the facial crest, and the caudal limit is the floor of the orbit. The caudal maxillary sinus communicates dorsally with the conchofrontal sinus through the large *frontomaxillary aperture*, and caudally with *sphenopalatine sinus*.

The maxillary sinuses are invaginated by the alveolar bone surrounding the roots of the last four cheek teeth. The mesial portion of the apex of the 4th maxillary premolar usually lies rostral to the rostral maxillary sinus, and the distal portion of the apex usually lies within the rostral maxillary sinus. The apex of the 1st maxillary molar lies entirely within the rostral maxillary sinus, and the apex of the 2nd maxillary molar lies directly beneath the maxillary septum, which separates the rostral and caudal maxillary sinuses. The apex of the 3rd maxillary molar lies entirely within the caudal maxillary sinus. The maxillary sinuses expand ventrally as the teeth continuously erupt.

The sphenopalatine sinus extends caudally from the caudal maxillary sinus and borders on parts of the palatine, sphenoid, ethmoid, and vomer bones. The sphenoid parts may be absent. The opening of the sphenopalatine sinus is located medially to the infraorbital canal.

**Surgery of the Paranasal Sinuses**

The paranasal sinuses can be exposed through a frontonasal osteoplastic flap or a maxillary osteoplastic flap. The frontonasal flap is the most versatile because it is easier to create and provides direct or indirect access to all compartments of the ipsilateral paranasal sinuses. The maxillary flap is more difficult to create than is the frontonasal flap, and it provides poor access to the ventral conchal sinus of horses less than 6 years old, but it provides good access the rostral and caudal maxillary sinuses. The maxillary flap is most commonly used to expose the apex of the first or second maxillary molar. The apex of the third maxillary molar is often best exposed through a frontonasal flap.

**Frontonasal Osteoplastic Flap**

To create a frontonasal flap, a three-sided, rectangular, cutaneous incision, with slightly rounded corners, is created over the conchofrontal sinus and extended through the periosteum. The caudal portion of the incision is created perpendicular to the dorsal midline, midway between the supraorbital foramen and the medial canthus of the eye. This incision extends laterally from the dorsal midline to a point about 1.5 to 2 cm medial to the medial aspect of the rim of the orbit. The rostral portion of the incision begins on the dorsal midline, 1 to 2 cm caudal to where the nasal bones begin to diverge, and extends laterally, perpendicular to the long axis of the head and parallel to the caudal portion of the incision to an imaginary line extending from the medial canthus of the eye to the nasoincisive incisure. The lateral portion of the incision connects the most lateral extent of the caudal and rostral portions of the incision. The incision should not cross the nasolacrimal duct, which courses between the medial canthus of the eye and the nasoincisive incisure. A portion of the lateral segment of the incision can be angled rostromedially, if necessary, to avoid the course of the duct. The periosteum is reflected for a few millimeters on each side of the periosteal incision using a periosteal elevator.
Bone exposed by the incision is cut with an oscillating bone saw or a motorized cast cutter with a sharp blade or with a mallet and osteotome. To avoid overheating bone, the blade of the saw should be cooled with sterile, normal saline solution. The bone is cut at a 45-degree angle so that the flap’s external lamina is slightly larger than its internal lamina.

The flap is partially elevated using a chisel or periosteal elevator so that the surgeon’s fingers can be introduced beneath the flap. The flap is fractured at its base, close to the dorsal midline. The flap remains hinged at its base by skin, subcutaneous tissue and periosteum. Elevating the flap exposes the conchofrontal sinus, which communicates with the caudal maxillary sinus through the large frontomaxillary aperture. When the architecture of the sinuses has not been distorted by disease, the maxillary septum can be seen beneath the rostral edge of the frontomaxillary aperture. To expose the rostral maxillary and ventral conchal sinuses, the maxillary septum is removed with a scissors. The ventral conchal sinus is located medial to the infraorbital canal, and the rostral maxillary sinus is located lateral to the canal. The infraorbital canal is supported by a thin plate of bone that separates these two compartments. All or a portion of the reserve crowns of the 4th premolar and 1st and 2nd molars of horses less than 4 years old completely fill the rostral maxillary sinus.

The medial wall of the dorsal or ventral conchal sinus is often perforated to establish drainage of the sinuses into the ipsilateral nasal cavity. A portal for drainage need not be established if the nasomaxillary aperture is patent, and rarely is the nasomaxillary aperture obstructed. Blood or lavage fluid seen exiting the nasal cavity can be used as evidence that the nasomaxillary aperture is patent. A portal to remove gauze packing or to allow lavage of the sinuses can be created into the frontal sinus, caudal to the caudal border of the flap, or into the caudal maxillary sinus about 2 cm ventral and 2 cm rostral to the medial canthus of the eye, through a 2-to 3-cm, longitudinal, skin and periosteal incision, using a 3/8-inch Galt trephine.

Maxillary Osteoplastic Flap

The most common indication for creating a maxillary osteoplastic flap is repulsion of a maxillary molar, which is best performed with the horse anesthetized. Exposing the apex of a maxillary molar through an osteoplastic maxillary flap, rather than through a trephine hole, permits visual examination of a large portion of the sinuses and permits manipulation of dental instruments.

To create a dorsally hinged, osteoplastic maxillary flap, a three-sided incision through the skin, subcutis, and periosteum, with rounded corners, is created within the confines of the boundaries of the rostral and caudal maxillary sinuses. The cutaneous incision begins at a point about 1 cm rostral to the orbit, slightly below the medial canthus, and extends ventrally, perpendicular to the facial crest to a point about 1 cm dorsal to the facial crest. The incision is extended rostrally, parallel to the facial crest to a point about 1 cm caudal to the rostral end of the facial crest, and turned dorsally and extended to a point about 1 cm caudal to the infraorbital foramen. The rostral portion of the incision extends into the nasolabialis and levator labii superioris muscles and may transect the angularis oculi artery and vein.

Periosteum is reflected slightly, and the maxillary bone is cut along the incision, at a 45-degree angle, using an oscillating saw or a mallet and an osteotome. The flap is pried upward until it
fractures dorsally to expose the interior of the rostral and caudal maxillary sinuses. Septal attachments to the bone must sometimes be severed with an osteotome before the flap can be pried dorsally. If at the conclusion of surgery, the need for lavage of the sinuses is anticipated, a portal for lavage can be created over the frontal bone into the conchofrontal sinus or through the maxillary bone, caudal to the flap, into the caudal maxillary sinus.

After returning the frontonasal or maxillary flap to its normal position at the end of surgery, the subcutaneous tissue is apposed with absorbable sutures, and the margins of the skin incision are apposed with skin staples. Because the bone is bevelled, it need not be attached to surrounding bone, and apposing the margins of the inelastic periosteum is difficult to impossible. The flap is compressed with a bolus bandage or with gauze swabs anchored by elastic, adhesive tape placed in a figure-of-eight fashion around the head. Gauze packed into the sinuses can be removed through the trephine hole, usually the next day, and the stent or elastic bandage is removed at 4 to 7 days. The portal created for removing gauze packing or for lavage of the sinuses can be closed with staples or sutures after the portal is no longer required.

Creating an Osteoplastic Flap with the Horse Standing

Surgery of the paranasal sinuses is usually performed with the horse anesthetized and recumbent, but most surgeries of the paranasal sinuses that can be performed through a frontonasal flap can also be performed with the horse standing, thereby eliminating the risks and expense of general anesthesia.4 Surgery of the paranasal sinuses performed with the horse standing results in less hemorrhage than surgery performed with the horse anesthetized and recumbent. When surgery of the sinuses is performed with the horse standing, the structures within the sinuses are oriented in a normal position.

A horse selected to receive surgery of the sinuses while standing should be compliant and should not resent movement of hands and instruments about its head. Surgery of the paranasal sinuses performed with the horse standing is most safely performed with the horse restrained in stocks. The horse is sedated with detomidine HCl (0.01 – 0.02 mg/kg IV or 0.03-0.04 mg/kg intramuscularly) and butorphanol tartrate (0.02 – 0.05 mg/kg, IV) or morphine (0.15 mg/kg, IV). The horse can be re-sedated with xylazine (0.5mg/kg, IV) or detomidine (0.01mg/kg, IV), when needed. The horse’s head should be supported on a stand.

The proposed site of incision is infused subcutaneously with local anesthetic solution, and the paranasal sinuses are desensitized by anesthetizing the ipsilateral maxillary nerve or by infusing 30 to 40 mL of local anesthetic solution into the sinuses through a small hole created several centimeters medial to the medial canthus of the eye with a Steinmann pin. To anesthetize the maxillary nerve, a 20-gauge, 3.5-inch, spinal needle is inserted ventral to the zygomatic process of the malar bone and dorsal to the transverse facial vessels on an imaginary line drawn perpendicular to the long axis of the head through the lateral canthus of the eye, until the needle strikes bone, usually at a depth of about 5.0 to 6.5 cm (2 to 2.5 inches).5,6 The horse may jerk its head if the needle contacts the nerve. Ten to 15 mL of local anesthetic solution is deposited at this site. The ipsilateral paranasal sinuses are usually desensitized within 15 minutes. Another technique of anesthetizing the maxillary nerve at the pterygopalatine fossa is to insert the point of a 20- to 22-gauge, 8.9-cm (3.5-inch) spinal needle just ventral to the ventral border of the
zygomatic process of the temporal bone at the narrowest point of the zygomatic arch and direct the needle rostromedially and ventrally in the direction of the third molar of the contralateral maxillary dental arcade.\textsuperscript{6}

The surgical site is prepared for surgery after the sinuses and skin at the proposed site of incision are desensitized. The surgical site should not be draped, so that the horse’s reactions to sinusotony can be monitored. A lip twitch should be applied to the horse when the bone is cut to prevent the horse from moving. The paranasal sinuses are inspected, and the horse is treated for disease encountered. The flap is replaced and sutured as described above.

References