Equine ethmoidal nerve: Course to the nasal cavity and frontal sinus and role in sinonasal surgery

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Abstract
Sinonasal surgery of the horse to remove inspissated exudate or a mass, such as an osteoma, a cyst, a progressive ethmoidal hematoma, or a neoplasm, is common and in recent years has become commonly performed with the horse standing to eliminate risks and expense associated with general anesthesia and to decrease hemorrhage. The maxillary nerve has been the nerve anesthetized to allow surgery of the ipsilateral paranasal sinuses and nasal cavity to be performed with the horse standing, but clinicians have noted that the entire sinonasal area is not desensitized by anesthetizing only the maxillary nerve. We have shown that the ethmoidal nerve innervates the caudal portion of the sinonasal region and must be anesthetized to completely desensitize sinonasal structures.

Introduction
Equine sinonasal surgical procedures are frequently performed with the horse standing to avoid the risks and expense associated with general anesthesia and to decrease hemorrhage. Anesthesia of the maxillary nerve at the rostral aspect of the pterygopalatine fossa has been the method chosen by surgeons to desensitize the ipsilateral sinonasal cavities, but anesthesia of the posterior ethmoidal nerve has also been described to desensitize the sinonasal cavities. Domestic mammals, however, unlike human beings, do not have a posterior ethmoidal nerve. Human beings have an anterior ethmoidal nerve, in addition to the posterior ethmoidal nerve, and together these two nerves innervate an area similar to that innervated by the single ethmoidal nerve of domestic animals. The technique used to anesthetize the posterior ethmoidal nerve (PET block) resembles the technique used to anesthetize the maxillary nerve. The tip of the needle is inserted slightly more cranial to the site where the maxillary nerve is anesthetized and thus is near to the point at which the caudal nasal nerve branches from the maxillary nerve prior to where maxillary nerve enters the maxillary foramen. The caudal nasal nerve is known to innervate a large portion of the nasal cavity, but whether or not this nerve innervates the caudal portion of the nasal cavity and septum has been questioned. Anatomists have stated that the ethmoidal nerve innervates the caudal dorsal region of the nasal cavity (Nickel, Schummer, Seiferle, 1992; Sisson and Grossman, 1962). Recently a technique to block the ethmoidal nerve of the horse has been described (Caruso, Schumacher, Henry, 2015). Using this technique, the nerve is anesthetized in the caudal aspect of the retrobulbar space after it has exited the orbital fissure and passed dorsomedially over the optic nerve in route to the ethmoidal foramen to return into the cranial cavity. Our goal was to follow the route of the ethmoidal nerve from the ethmoidal foramen to the frontal sinus and nasal cavity to determine the nerve’s pattern of innervation of the nasal cavity and frontal sinus.

Methods & Materials
The heads of nine dead ponies and four dead horses were used to trace the ethmoidal nerve (branch of the nasociliary nerve from the ophthalmic nerve from the trigeminal nerve) from its origin in the brain stem to the frontal sinus and nasal cavity to delineate structures innervated by the ethmoidal nerve.

Results
We found that the ophthalmic nerve leaves the ventrolateral surface of the mesencephalon of the brain stem and courses rostrally with the maxillary nerve to exit the cranial vault via the orbital fissure along with cranial nerves III, IV & VI. The nasociliary nerve is dispatched in the caudal orbit and courses rostrally lateral to the optic nerve. It turns medially and passes dorsal to the optic nerve toward the medial wall of the orbit and penetrates the periorbita. The nasociliary nerve then divides into a rostral branch, the infraorbital nerve (Fig. 1, black arrow) which courses rostrally along the medial wall of the orbit toward the medial canthus of the eye and a caudal branch, the ethmoidal nerve (Fig. 1, white arrow), which courses caudally 1 cm and enters the cranial cavity via the ethmoidal foramen (Fig. 2) Here the ethmoidal nerve branches into dorsal (red arrow) and ventral (blue arrow) branches. In the cranial cavity, the nerves pass epidurally along the cribiform plate. The dorsal branch courses dorsally then rostrally (Fig. 3) and it gives off branches to the dorsal concha and ethmoidal labyrinth (Fig. 4), and finally continues to the frontal sinus (Fig. 5). The ventral branch passes ventromedially to the nasal septum (Fig. 2, blue arrow).

Discussion
Our results show that the ethmoidal nerve innervates the caudal dorsal region of the nasal cavity, caudal nasal septum and the frontal sinus which is similar to the reports of Nickel et al. (1992) and Sisson and Grossman (1962). Therefore, for surgery of exploration of the caudal dorsal nasal cavity and the frontal sinus, the ethmoidal nerve must be blocked. Nickel et al. record the infratrochlear nerve dispatching nerves in the rostral orbit which penetrate into the rostral portion of the frontal sinus; we did not observe such. However, an ethmoidal nerve block in the caudomedial orbit would likely desensitize the infraorbital nerve as well as the ethmoidal nerve.

Literature Cited
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