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Endoscope-Guided Balloon Sinuplasty of the Equine Nasomaxillary Opening

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Balloon sinuplasty of the nasomaxillary opening is an easily performed, non-invasive, clinically applicable technique that can be used in horses with primary sinusitis. Authors’ address: Department of Large Animal Clinical Sciences, Western College of Veterinary Medicine, 52 Campus Drive, University of Saskatchewan, Saskatoon, SK S7N 5B4, Canada; e-mail: dane.tatarniuk@usask.ca. © 2010 AAEP.

1. Introduction

Sinusitis is a common, clinically important cause of nasal discharge in the horse. Drainage of the paranasal sinuses is provided through the nasomaxillary opening, an anatomically narrow potential space. Sinusitis can result in obstruction of drainage from the paranasal sinus system through obstruction of the nasomaxillary opening. The contributing causes of obstruction include the nasomaxillary opening being anatomically narrow, hypertrophy of the sinus mucosa as a result of chronic inflammation, and accumulation of purulent material that acts to occlude the passageway.

Current treatment aims to lavage and drain the sinus in conjunction with antibiotic therapy, where indicated. The efficacy of lavage and draining is limited in certain cases, necessitating a sinus bone-flap procedure to remove purulent debris. Recently, a minimally invasive balloon sinuplasty technique has been developed for treatment of humans with chronic sinusitis. Balloon sinuplasty is a technique wherein a non-compliant balloon catheter is used to dilate inflamed sinus ostia, thus improving drainage.

Thus far, two large multicenter clinical trials have examined outcomes in human patients with chronic sinusitis that underwent balloon sinuplasty. Results show that 95.2% of patients had improved sinus symptoms at 40.2 wk post-operatively, and 80.5% of dilated ostia maintained patency at 6 mo. Extrapolated to the equine veterinary field, balloon sinuplasty of the nasomaxillary opening will augment current treatment protocols and increase drainage in horses with sinusitis.

The hypothesis is that performing balloon sinuplasty of the nasomaxillary opening of horses provides a minimally invasive means of increasing drainage from the paranasal sinuses. The purpose of this study is to describe a minimally invasive technique to increase drainage from the nasomaxillary opening in horses.

2. Materials and Methods

Five fresh cadaver heads and four live horses were used in the study. Standing balloon sinuplasty was performed in the four live horses.

Fresh and thawed, young (<5-yr-old) Quarter Horse heads were used for sinus drainage flow-rate
analysis (n = 5). Heads were affixed vertically in a vice. Two 4.5-mm sinusotomies were performed within the caudal maxillary sinuses bilaterally (two sinuses and four sinusotomies). The vertical distance between each sinusotomy (within a specific sinus) was 2 mm. An extension set was attached to a fluid pump and inserted into the dorsal sinusotomy site. The pump was started, and fluid flow rate was incrementally increased at rates of 50 ml/min at 300 mm Hg set pressure until fluid was seen to egress from the ventral sinusotomy. At this point, a steady state had been achieved in which fluid ingress was deemed to match egress. This was repeated at both dorsal sinusotomy sites per skull: left and right caudal maxillary sinuses, respectively. The balloon catheter was then passed through the caudal maxillary sinus and inflated to dilate the ostium, and the measurements were repeated.

Descriptive statistics were used to examine the normality of distribution and equality of variance of the data using a computer-based program. A paired t test was used to determine whether balloon sinuplasty resulted in a significant increase in the rate of fluid egress from the sinus system. The level of significance was set at p < 0.05.

A rigid balloon introducer was fabricated out of an insemination pipette using a midline sagittally sectioned cadaveric model as a guide for curvature (Fig. 1). The introducer had a working length of 425 mm with the distal tip curvature being a 45° S curve, with 75 mm of rise over 45 mm of length, and a 13-mm axial-to-abaxial deviation at the tip. The introducer allowed for direct guidance of the balloon catheter into the nasomaxillary opening.

In the live horse, the nasomaxillary opening was bathed in lidocaine through the biopsy portal of the endoscope before insertion of the introducer (Fig. 2). The introducer was passed into position within the nasomaxillary opening at the caudal recess of the middle meatus. The balloon introducer was seated within the nasomaxillary ostial fossa under direct endoscopic visualization of the nasal passageway and positioned using a rotating corkscrew movement to accommodate the curvature of the distal end (Fig. 3). After introducer placement, a lubricated 12-mm balloon diameter, 80-mm balloon length, 8-atmosphere burst pressure, 6-French shaft diameter balloon catheter was advanced through the introducer and continued 70 mm through the nasomaxillary opening into the caudal maxillary sinus (Fig. 5). The balloon was confirmed within the nasomaxillary opening through direct visualization of the catheter.
within the introducer, performing an endoscopic examination of the middle and ventral meati (to confirm that the catheter had not diverged from the ostial fossa) and appreciation of palpable resistance of the catheter as it entered the nasomaxillary ostium. An audible sound could be heard when advancing and inflating the catheter in the ostium, and collapse of the ventral conchal bulla was evident endoscopically. The balloon was inflated to 6 atmospheres for a set of three 30-s intervals to create a dilation of the ostium.

3. Results
Positioning of the balloon catheter was readily achieved in all heads. The technique was well-tolerated in all standing sedated horses. No major complications were encountered in performing the technique. Dilation was observed endoscopically and grossly in both live horses and cadaveric heads (Figs. 6 and 7). Drainage flow rates in the cadaver heads significantly increased after balloon dilation (compared with predilation flow rates; $p = 0.001$) (Table 1). The mean flow rate for the left and right caudal maxillary sinuses before balloon dilation was not significantly different ($p = 0.39$). Mean predilation flow rate was $285 \text{ ml/min}$ (standard deviation [SD] $\pm 110.7$; range $= 100–450 \text{ ml/min}; n = 10$). The mean flow rate post-dilation was $440 \text{ ml/min}$ (SD $\pm 132.9$; range $= 200–700 \text{ ml/min}; n = 10$).

4. Discussion
Dilation of the nasomaxillary ostium was easily achieved and provided a significant increase in drainage rates from the caudal maxillary sinus in all five cadaver heads ($p = 0.001$) (Fig. 8). Inflation of the nasomaxillary opening results in collapse of the ventral conchal bulla alone, because the dorsal roof...
of the nasal maxillary opening (the floor of the dorsal conchal sinus) is anatomically very rigid and does not manipulate under pressure applied by the inflated balloon. Thus, the increased drainage gained through balloon sinuplasty is purely derived from ventral deviation of the ventral conchal bulla. Endoscopic evaluation of the ostium, viewed from the nasal passage, revealed marked dilation of the nasomaxillary opening in the live horse. The improvement of flow rates within cadaver head models and gross observation of the nasomaxillary opening within live horse trials provides confirmation of technique applicability for providing dilation and improved drainage from the caudal maxillary sinus.

Currently, the alternative technique to balloon sinuplasty is fenestration of the nasomaxillary ostium or ventral conchal sinus through sinus-flap surgery. Advantages of balloon sinuplasty over fenestration are maintenance of the natural drainage angle, preservation of mucociliary elevator function, lack of significant hemorrhage, and ability to perform the procedure without general anesthesia. Fenestrations are known to stenose after surgery; however, endoscopic guidance is recommended, because it allows accurate placement of the introducer directly against the ostial fossa. Additionally, after insertion of the balloon catheter, the use of the endoscope confirms that the catheter has not diverged from the ostial fossa and has entered the nasomaxillary opening. Without the use of the endoscope, cannulation of the nasomaxillary opening is technically more difficult to achieve.

Minor complications encountered in all live horse trials included epistaxis from nasal mucosal trauma to the caudodorsal scroll of the middle meatus during insertion of the introducer. Epistaxis was con-

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**Table 1.** Summary of Drainage Rates for the Caudal Maxillary Sinuses in Five Cadaver Heads (ml/min at 300 mm Hg) Before and After Dilation of the Nasomaxillary Opening with a 12-mm-Diameter, 80-mm-Long Balloon Catheter Dilated at Six Atmospheres

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**Fig. 7.** Skull. Transverse section at the level of the orbit viewed from the caudal maxillary sinus looking rostral. Right blue arrows denote normal nasomaxillary ostial opening; left black arrows denote dilated ostium.

**Fig. 8.** Balloon sinuplasty procedure as viewed from the sinus in a cadaver head. (A) Normal sinus anatomy nasomaxillary opening (NMO). (B) The balloon catheter is introduced through the NMO. (C) The balloon is inflated with saline solution to 6 atmospheres for 30 s. (D) The balloon is deflated and removed, leaving a dilated NMO.
sidered minimal and did not require treatment. Insertion of the introducer was the most objectionable aspect of the technique; however, objection was reduced through application of local anesthetic to the middle meatus, ventral meatus, and nasomaxillary opening before introducer insertion.

Thus far, 11 horses with sinusitis have undergone the balloon sinuplasty technique (eight horses with primary sinusitis and three horses with secondary sinusitis). In all 11 cases, successful dilation of the nasomaxillary opening was achieved. Follow-up at 6 mo showed that the nasomaxillary opening remained dilated in two of eight primary sinusitis horses. There was one failure of treatment because of lack of rostral maxillary sinus lavage (where surgery to clear the sinusitis was indicated). The remaining eight horses were not rescoped; however, sinusitis did not reoccur in these cases.

Balloon sinuplasty of the nasomaxillary opening is an easily performed, clinically applicable technique for use in horses with primary sinusitis.

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**References and Footnote**


*CRE Fixed Wire Balloon Dilator, Boston Scientific Corp., Natick, MA 01760.*