Endoscopic appearance of the glossoepiglottic fold of normal horses

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Abstract
The objective was to characterize the endoscopic appearance of the glossoepiglottic fold (GEF) in normal horses. Six clinically normal adult Quarter Horses between 5 and 7 years of age were used and ranged from 480 to 520 kg body weight. Prior to oropharyngeal endoscopic examination, all horses had demonstrated normal function of the upper respiratory tract during high-speed treadmill examination. The horses were cantered at between 6.5 and 8.0 m s⁻¹ on a high-speed treadmill until fatigued and unable to maintain position on the treadmill. All horses were able to canter for at least 5 min. Oropharyngeal endoscopy was performed under intravenous general anaesthesia. The ventral aspect of the epiglottis and the GEF were examined with the aid of a specially designed epiglottic elevator. The endoscopic appearance of the oropharynx was documented using digital image capture technology Karl Storz AIDA Vet compact data archiving system (Karl Storz Veterinary Endoscopy America Inc., Goleta, CA, USA). In all horses, the GEF attached to the most caudo ventral aspect of the base of the epiglottis. The mucosa of the GEF was consistently plicated in the transverse plane, and in no horse, was there plication in the sagittal plane only. The clinical relevance included malformations of the GEF, which have been implicated in the etiopathogenesis of dorsal displacement of the soft palate. The results of this study may facilitate the differentiation of normal oropharyngeal anatomy from malformations (frenula) that may contribute to upper airway dysfunction.

Keywords: glossoepiglottic fold; horse

Introduction
In the literature, detailed anatomic descriptions of normal and abnormal laryngeal and pharyngeal structures as observed through nasopharyngeal fibre-optic endoscopy are widely available¹. In contrast, the caudo ventral oropharynx has not been as well described. This region cannot be observed during a routine (standing) nasopharyngeal endoscopic examination; the best way to visualize the caudal oropharynx is through oropharyngeal endoscopy. This is problematic in the conscious horse as it requires valuable endoscopic equipment to be placed in the oral cavity. Additionally, movement of the tongue in a conscious horse can make a thorough examination of the caudal oropharynx difficult.

One structure believed by some authors to be of clinical significance in the oropharynx is the glossoepiglottic fold (GEF)². A congenital abnormality of this structure, described as a frenulum of the epiglottis, has been reported previously in four foals and was implicated in the abnormal epiglottic function and dorsal displacement of the soft palate (DDSP) observed in those animals³. More recently, a report of persistent DDSP in an adult horse has been attributed to a frenulum of the epiglottis⁴. The epiglottis and tongue originate from swellings on the floor of the pharynx in the embryo. These swellings are in contact embryologically, and incomplete separation of the swellings could result in an abnormal connection, i.e. post-epiglottic frenulum⁵. To date, this structure has been poorly described in the literature. Anatomical texts

Abbreviations: GEF glossoepiglottic fold; DDSP, dorsal displacement of the soft palate.
identify this fold as having contact with the base of the tongue rostrally, the ventral aspect of the base of the epiglottis caudo-dorsally and to the hyoid bone rostroventrally through its associations with the hyoepiglottic ligament and the hyoepiglotticus muscle, respectively (Fig. 1)².

The purpose of this study was to document the endoscopic appearance of the GEF in horses with normal upper airway function, so that variations of normal anatomy may be differentiated from abnormalities that may contribute to upper respiratory tract dysfunction.

Materials and methods

Six clinically normal adult Quarter Horses between 5 and 7 years of age and ranging from 480 to 520 kg bodyweight were obtained for the purposes of this study. All horses were currently being used for respiratory physiology studies at Oklahoma State University (OSU). Documentation of normal upper airway function was predicated upon a lack of exercise intolerance and abnormal airway noise during numerous high-speed treadmill examinations prior to the commencement of this study. Horses performed a single high-speed treadmill examination, starting with a warm-up of 5 min at 2 m s⁻¹ and 1.5° incline, followed by a 5 min at 3.8 m s⁻¹ and 2.5° incline. The horses then cantered (depending upon the size and subjective gait of the horse) on a 3.5° incline until they were fatigued and unable to maintain position on the treadmill. Duration was variable, but all horses were capable of cantering for at least 5 min.

To facilitate examination of the ventral aspect of the epiglottis, a specialized epiglottic elevation instrument was designed. A 4-feet (105 cm) length of stainless steel rod of 3/16th in. (4.5 mm) diameter was forged to give a spatulated triangular tip 2 in. (48 mm) long and 1 in. (24 mm) wide. The other end of the steel rod was folded back on itself for a length of 5 in. (120 mm) and bent through 90° to provide a handle. A gentle downward curve was incorporated into the design of the instrument. Metal inert gas welds were used to seal the rod ends at the handle and retractor tip. Any rough edges were then removed with a bench-top angle grinder (Fig. 2a and 2b).

Approval from the Institutional Animal Care and Use Committee of OSU was obtained. All horses were placed under general anaesthesia for the purpose of safe and complete endoscopic examination of the oropharynx. General anaesthesia was induced using an intravenous protocol of xylazine hydrochloride (1.1 mg kg⁻¹), diazepam (0.05 mg kg⁻¹) and ketamine hydrochloride (2.2 mg kg⁻¹). A PVC pipe speculum/gag provided oral access of instrumentation between the maxillary and mandibular incisors. The ventral aspect of the epiglottis in the oropharynx was examined by dorsally displacing the soft palate with the epiglottis elevator. A 1 m flexible endoscope⁵ was then passed through the mouth gag for oropharyngeal examination. The epiglottis elevator was then used to manipulate the epiglottis dorsal and caudal, so that the nature of the GEF and its relationship to the ventral aspect of the epiglottis could be assessed. The endoscopic appearance of the oropharynx was documented using digital image capture technology.

Conclusion

The endoscopic appearance of the GEF and its attachment to the epiglottis was consistent in all horses.

(© Olympus GIF-2T100 104 cm fibre-optic flexible video endoscope (Olympus America Inc., Center Valley, PA, USA).
The fold ended at the caudal aspect of the ventral epi-
glottis with no redundant mucosa reflected rostrally or
plicated sagitally along the midline of the ventral epi-
glottis (Figs 3 and 4).

Discussion

This study served to document the normal endoscopic
appearance of the GEF and its relationship to the ven-
tral aspect of the epiglottis. In all cases, the GEF was
plicated in the transverse plain at the junction of the
fold with the epiglottis (Fig. 3). In none of the
horses was there evidence of subepiglottic mucosa
plicated in the sagittal plain and extending rostrally
along the ventral aspect of the epiglottis towards the
apex as reported previously (Fig. 5).

The appearance of the GEF in the horses examined
in this study contrasts with the anomalies described by
Yarbrough et al. and Moorman et al., where an epi-
glottic frenulum was identified as a cause of persistent
DDSP. During the act of swallowing, the epiglottis
moves caudally to cover the opening of the larynx as
the swallowed material moves dorsally from the oro-
pharynx to the opening of the oesophagus. A substan-
tial frenulum could impair this movement, resulting in
dysphagia. This hypothesis is supported by the fact
that in both reports, affected horses had dysphagia
that resolved with transection of a subepiglottic
frenulum.

Whether an epiglottic frenulum is a cause of DDSP
(and subsequent exercise intolerance) is less clear.
The response of some clinicians and researchers in
this field to the published case report by Moorman
et al. would indicate that the significance of a sub-
epiglottic frenulum and its role (if any) in the etio-
pathogenesis of DDSP are controversial. The horse
is unique in domestic athletes in being an obligate
nasal breather due to the normal orientation of
the epiglottis relative to the caudal edge of the soft
palate, and DDSP is a well-recognized cause of exer-
cise intolerance. Whether the epiglottis has a clear
role in preventing DDSP is less clear. Various treat-
ments have been described based on the premise
that the epiglottis restrains the soft palate in the
ventral position, but these treatments are not universally successful. In the case described by Moorman et al., persistent DDSP did not resolve with transection of the subepiglottic frenulum, while in the case series described by Yarborough et al., no abnormal upper respiratory function was reported by the owners of the three foals surviving to adulthood. Upon review of the clinical evidence available in the literature, it may be more appropriate to make an association between the presence of an epiglottic frenulum and dysphagia rather than DDSP, as follow-up treadmill endoscopic examinations of the upper respiratory tract are lacking in all cases of subepiglottic frenula published to date.

In this study, six horses with normal upper airway function demonstrated considerable uniformity in the appearance of the GEF as visualized through oropharyngeal endoscopy. The subepiglottic structure similar to that identified by Moorman et al. was not found in any of the horses examined (Fig. 5). It is possible that the sample size utilized in this study was too small to document all variations of normal anatomy. The results of this study may facilitate the differentiation of normal oropharyngeal anatomy from malformations believed by some authors to contribute to upper airway dysfunction.

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References