

The Laryngeal Tie-Forward Procedure to Alleviate Aspiration of Feed Caused by Hypoplasia of the Soft Palate of an Adult Mare

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# 1 Abstract

2 **Background.** An adult mare, presented to the University of Tennessee's Veterinary Medical  
3 Center because of chronic, persistent coughing and abnormal respiratory noise, was found,  
4 during endoscopic examination of its nasopharynx and larynx, to have hypoplasia of the caudal  
5 fourth of its soft palate and an aryepiglottic fold entrapment. The mare had developed chronic  
6 discharge of feed from the nares after the aryepiglottic fold entrapment was relieved with a laser,  
7 using endoscopic guidance.

8 **Methods.** The mare received a laryngeal tie forward procedure to ameliorate discharge of feed  
9 from the nares by decreasing the gap between the apex of the epiglottis and the soft palate.

10 **Results.** The distance between the epiglottis and the soft palate appeared to have been reduced  
11 during endoscopic examination of the nasopharynx, and the horse no longer experienced  
12 discharge of feed from the nares or persistent coughing. The horse continued to produce  
13 abnormal respiratory noise but was able to be used for trail riding..

14 **Discussion.** The tie-forward procedure should be considered as a treatment to ameliorate signs of  
15 hypoplastic soft palate in horses, if the palatal defect is short.

# 16 Introduction

17 Congenital palatal deformities of horses have been identified in 0.01-4% of the equine  
18 population (Riley, Yovich & Bolton 1991). Most involve the caudal half or third of the soft  
19 palate, but occasionally, the entire soft palate and much of the hard palate are involved. A  
20 palatal defect of foals produces typical clinical signs, including streaming of milk from the nasal  
21 cavity during and after nursing and signs of pneumonia. Foals with a palatal defect severe

enough to result in aspiration of feed are often euthanized, because surgery to repair the soft palate is difficult and associated with a high incidence of complications (Bowman et al. 1982; Ducharme 2012; Semevolos & Ducharme 1998). An owner of a horse with a congenital palatal deformity may not present the horse for investigation of the cause of clinical signs caused by the defect until the horse has reached maturity, if the signs caused by the defect are mild (Barakzai, Fraser & Dixon 2014; Jones 1975; Murray et al. 2013).

The laryngeal tie-forward procedure was first described in 2005 as a treatment for horses for obstruction of the airway and decreased performance caused by intermittent dorsal displacement of the soft palate (Woodie et al. 2005). Because this procedure advances the larynx rostrally and dorsally, we theorized that this procedure might be beneficial in ameliorating aspiration of feed resulting from a soft palatal defect by decreasing the gap between the soft palate and the epiglottis. We report the details of an adult horse that underwent a laryngeal tie-forward procedure to ameliorate clinical signs associated with a hypoplastic soft palate.

## Case History

A 6-year-old, American Paint Horse mare was presented to the University of Tennessee's Veterinary Medical Center because it made an abnormal respiratory noise at exercise and experienced intermittent paroxysms of coughing. The mare coughed frequently while eating hay and occasionally while grazing at pasture; coughing had increased in frequency and intensity during the past month. The horse neither coughed while being exercised nor had abnormal nasal discharge.

## Clinical Findings, Diagnosis, and Treatment

Prominent wheezes were auscultated, using a rebreathing bag, on the right side of the thorax, and a mild degree of bronchial mineralization within the thorax was seen during examination of right lateral radiographs of the chest.



Figure 1: Aryepiglottic entrapment and a soft palatal defect approximately 2 cm long and 2.5 cm wide

Aryepiglottic entrapment and a soft palatal defect, symmetric on the right and left sides, approximately 2 cm long and 2.5 cm wide, were observed during endoscopic examination of the nasopharynx and larynx. Feed was not observed in the nasopharynx or trachea, though the horse had had access to feed before being examined endoscopically.

The aryepiglottic fold entrapment was resolved by dividing the entrapping subepiglottic tissue axially, with a 25 W diode laser<sup>1</sup> using endoscopic guidance, with the horse sedated, after desensitizing the nasopharynx and larynx by applying local anesthetic solution topically to these regions. The horse was discharged the same day to the owner, who was instructed to feed the horse on the ground and to administer phenylbutazone (VetriBute<sup>2</sup>; 2.2 mg/kg, orally, q12h) for 10 days. Resolution of the aryepiglottic fold entrapment was observed during endoscopic examination of the mare's nasopharynx and larynx 3 weeks later. The appearance of the epiglottis was normal (Figure 2).



Figure 2: Resolution of the aryepiglottic fold entrapment was observed.

The appearance of the epiglottis was normal

The horse was re-evaluated 7 weeks after transecting the entrapping aryepiglottic fold, because the episodes of paroxysmal coughing had increased, and because, within the past few days, feed was observed, for the first time, discharging from the nasal cavity while the horse ate. We observed, during endoscopic examination of the upper portion of the horse's respiratory tract, feed within the nasopharynx and trachea. To ameliorate these signs associated with the palatal defect, a laryngeal tie-forward procedure was performed, theorizing that this procedure, by decreasing the space between the epiglottis and the soft palate, might ameliorate the clinical signs associated with the cleft palate.

For this procedure, the mare received procaine penicillin G (PenOne Pro<sup>2</sup>; 22,000 u/kg bwt, i.m.), gentamicin sulfate (Gentamicin Sulfate Solution<sup>2</sup>; 6.6 mg/kg bwt, i.v.) and flunixin meglumine (Prevail<sup>2</sup>; 1.1 mg/kg, i.v.) before surgery. She was sedated with romifidine (Sedivet<sup>3</sup>; 40 µg/kg bwt, i.v.), and anesthesia was induced with a combination of ketamine HCl (Zetamine<sup>2</sup>; 2.2 mg/kg bwt, i.v.) and diazepam (Valium<sup>4</sup>; 0.01 mg/kg bwt, i.v.). A surgical plane of anesthesia maintained with isoflurane (IsoFlo)<sup>5</sup> vaporized by oxygen and delivered through a semi-closed system into a cuffed endotracheal tube inserted orally into the trachea. The laryngeal

tie-forward procedure was performed, as previously described (Ducharme *et al.* 2003), with the horse in dorsal recumbency, through a 10-cm long cutaneous incision, created on the ventral midline, that began 1 cm caudal to the cricoid cartilage and extended to the rostral aspect of the lingual process of the basihyoid bone. The incision was extended through the paired sternohyoideus muscles to expose the larynx and basihyoid bone.

After transecting the tendon of insertion of the right and left sternothyroideus muscles, a suture of 7-metric polyester (Tricron)<sup>6</sup> was passed through the left lamina of the thyroid cartilage ventral to the level of insertion of the tendon of the sternothyroideus muscle. A suture was placed through the right lamina in a similar fashion. The dorsal limb of the suture on the left and the ventral limb of the suture on the right were passed dorsal to the basihyoid bone, adjacent to the left surface of the lingual process of that bone, and the dorsal limb of the suture on the right and the ventral limb of the suture on the left were passed dorsal to the basihyoid bone, adjacent to the right surface of the lingual process of that bone. With the head and neck flexed, and with the rostral border of the thyroid cartilage positioned slightly rostral to the body of the basihyoid bone, the dorsal limb of the right suture was tied to the dorsal limb of the left suture, and the ventral limb of the right suture was tied to the ventral limb of the left suture, over the ventral aspect of the lingual process. The incision exposing the larynx and basihyoid bone was closed in three layers.

The mare received sulfamethoxazole and trimethoprim (Sulfamethoxazole-Trimethoprim<sup>7</sup>; 25 mg/kg bwt, orally, q12h) and phenylbutazone (VetriBute<sup>2</sup>; 2.2 mg/kg bwt, orally, q12h) for 5 days after surgery. The position of the larynx and hyoid bones was not examined

radiographically before or after surgery. The mare was discharged the day after surgery. The owner was instructed to feed the mare using a hay net or hay rack, placed at shoulder level, and to restrict the mare's activity for 3 weeks. The owner was advised to allow the mare unrestricted activity at pasture at 2 weeks after surgery.

### Outcome

The owner reported 8 months after surgery that the surgical site had healed without complication, and that since surgery, the mare no longer coughed, and feed no longer discharged from the nasal cavity.



Figure 3: The tip of the epiglottis failed to contact the soft palate, but that the length of the space between the tip of the epiglottis and the soft palate had been reduced by about one-third.

We observed, at that time, during endoscopic examination of the mare's nasopharynx and larynx, that the tip of the epiglottis failed to contact the soft palate, but that the length of the space between the tip of the epiglottis and the soft palate had been reduced by about one-third (Figure 3). The decrease in space was not assessed objectively using radiographic assessment, because the horse's nasopharyngeal/laryngeal region was not examined preoperatively or postoperatively.

### Discussion

The right and left palatopharyngeal arches fuse rostrally to caudally, and therefore, if the hard palate of a horse is congenitally deformed, the soft palate must also be deformed (Barakzai et al. 2014). The majority of palatal deformities are confined to the soft palate (Murray et al. 2013; Riley et al. 1991). Clinical signs associated with palatal defects, such as milk flowing from the nasal cavity after the foal nurses and signs of aspiration pneumonia, are usually observed soon after the foal is born (Barakzai et al. 2014). Some horses with defects in the palate may display no clinical signs associated with the defect (J. Schumacher, unpublished data), or the clinical signs produced by the defect are so mild that the owner fails to seek a diagnosis of the condition causing the clinical signs until the horse has reached maturity (Barakzai et al. 2014). In one report of horses affected with cleft palate, the cleft remained undiagnosed in 16% of horses until the horses were more than 1 year old (Murray et al. 2013). Typical clinical signs displayed by adult horses with a palatal deformity include discharge of feed from the nasal cavity, abnormal noise emanating from the upper portion of the airway during exercise, dysphagia, and signs of aspiration pneumonia (Murray et al. 2013).

The horse of this report appeared to have bilateral hypoplasia of the soft palate, a condition rarely reported in horses (Bertone, Traub-Dargatz & Trotter 1986; Proudman et al. 1991; Riley et al. 1991). This condition may develop during embryogenesis when the lateral palatine processes fail to elongate toward midline (Riley et al. 1991). The palatal defect of other horses reported to suffer from bilateral hypoplasia of the soft palate was characterized by the presence of a uvula-like structure on the caudal edge of the soft palate, whereas the horse of our report had no such structure. Bilateral hypoplasia of the palate may be accompanied by a uvula-like structure if midline of the palate continues to elongate (Riley et al. 1991 A foal with bilateral hypoplasia

reported by Riley et al (1999) and an adult horse with bilateral hypoplasia reported by Bertone et al. (1986) were euthanized shortly after diagnosis. A similarly affected horse reported by Proudman et al (1991) was managed through dietary modifications to decrease the risk of aspiration. The laryngeal tie-forward procedure was effective eliminating clinical signs of hypoplasia of the soft palate in the horse of our report and may be effective in eliminating these signs in other similarly affected horses.

Cleft soft palates have been repaired through a laryngotomy (Ducharme 2012), pharyngotomy (Ducharme 2012; Mason et al. 1977; Semevolos & Ducharme 1998), or transorally (Stickle, Goble & Braden 1973), but exposure to the soft palate using these approaches is poor. The soft palate is best exposed for repair by mandibular symphysiotomy (Jones 1975; Stickle et al. 1973) or pharyngotomy (Mason et al. 1977), or a combination of mandibular symphysiotomy with either laryngotomy (Murray et al. 2013) or pharyngotomy (Holcombe, Robertson & Richardson 1994). Regardless of the approach, exposing the palate and repairing the cleft are difficult, and the likelihood of failure of repair of the cleft is high (Ducharme 2012).

Others have described using the tie-forward procedure to diminish clinical signs of cleft palate (Barakzai et al. 2014; Charman 2011). A one-year-old miniature horse suffering from dysphagia, coughing, and signs of respiratory infection resulting from a cleft palate was reported to be free of these signs 12 months after undergoing tie-forward surgery (Charman 2011). Barakzai *et al.* (2014) reported that a 4-year-old pony with a mild cleft of the soft palate had amelioration of discharge of feed from the nasal cavity after undergoing the laryngeal tie-forward procedure. The space between the base of the epiglottis and the soft palate caused by the cleft was no longer

apparent during endoscopic examination of the pony's nasopharynx and larynx after surgery. During endoscopic examination of the pony's nasopharynx and larynx 9 months later, performed because of reappearance of clinical signs of cleft palate, the larynx was observed to have returned to its original position, creating a space between the soft palate and epiglottis. The owner reported, however, that clinical signs associated with the cleft palate remained less obvious than before surgery, despite the failure of the laryngeal tie-forward surgery to maintain the larynx in a dorsal and rostral position (Barakzai et al. 2014). It is for these reasons that we theorized the tie forward procedure would also improve clinical signs with palatal hypoplasia.

The mare in this report showed clinical signs associated with the palatal defect only after the concurrent epiglottic entrapment was resolved, probably because removing the tissue entrapping the epiglottis increased the space between the soft palate and the epiglottis. We and others have observed that aryepiglottic fold entrapment often occurs concurrently with palatal defects (Bertone et al. 1986; Cook 1974; Haynes & Qualls 1981). Resolving the entrapment may worsen the clinical signs associated with cleft palate, as it did for the mare of this report, because removing the entrapping tissue increases the gap between the soft palate and the epiglottis. We caution against removing subepiglottic tissue entrapping the epiglottis of horses with a concurrent soft palatal defect, unless the entrapping tissue appears to be deforming the epiglottis, causing the epiglottis to shorten.

The laryngeal tie-forward procedure moves the larynx rostrally and dorsally, and this change in position can be confirmed by comparing pre-operative and post-operative radiographic projections of the larynx and nasopharynx (Offord et al. 2015). The basihyoid bone is seen to

have moved dorsally and caudally after the procedure, and the larynx dorsally and rostrally. The position of the larynx of the mare of this report was not examined radiographically, either before or after surgery, because of financial constraints imposed by the owner.

The laryngeal tie-forward procedure may have been successful in resolving signs of palatal hypoplasia of the mare in our report by decreasing the space between the soft palate and the epiglottis, or by making swallowing more efficient (Virgin et al. 2016). In an experimental model of dysphagia, shortening the distance from the base of the tongue to the esophagus, accomplished by the tie-forward procedure, helped facilitate the transfer of boluses of food through the pharynx (Virgin et al. 2016).

A recent report described the outcome of 26 horses with cleft soft palate treated by suturing the cleft, in three layers, through a mandibular symphysiotomy and laryngotomy (Murray et al. 2013). The repaired soft palate of 12 of these horses dehiscd at the caudal extent of the repair, and two horses developed an oronasal fistula (Murray et al. 2013). Only 9 (39%) horses undergoing primary closure of the cleft using this approach were observed to have an intact repair of the palate during endoscopic examination of the nasopharynx and larynx, performed as early as eight days post-operatively (Murray et al. 2013). Because many horses in this report did not have long-term endoscopic follow-up, this report may overestimate the number of repairs that remained intact. Fifty percent of horses in this report had milk or feed present in the nasal cavity after the repair, 8 percent had dehiscence of the cutaneous incision, and 4 percent had instability of the mandibular symphysis. Still, the success of repair reported by these authors was far better than that reported by Bowman *et al.* (1982), who reported that 10 of 11 horses suffered

failure of palatal repair, though 3 of those horses had undergone repair of both the hard and soft palates (Bowman et al. 1982).

The laryngeal tie-forward procedure is associated with a low incidence of complications. In a report of 116 horses that underwent a tie-forward procedure as a treatment for intermittent dorsal displacement of the soft palate, only 8 horses (7 %) experienced a complication (Woodie *et al.* 2005). Complications included formation of a seroma at the surgical site, dysphagia, dyspnea immediately after recovery from general anesthesia, and formation of a laryngeal granuloma (Woodie et al. 2005).

Based on the outcome of the mare in this report and the outcome of horses undergoing the laryngeal tie-forward procedure as a treatment for cleft soft palate in other reports (Barakzai et al. 2014; Charman 2011), we conclude that the laryngeal tie-forward procedure may ameliorate clinical signs associated with palatal hypoplasia of some horses. The tie-forward procedure has a lower incidence of complications than does primary repair of a soft palatal defect, is technically far easier to perform, and is more likely to result in improvement of clinical signs, especially when the defect is characterized by a wide deficit of tissue, as occurs with palatal hypoplasia.

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## Manufacturers Addresses

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2. Vetone, Boise, ID

3. Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO

4. Hospira, Inc., Lake Forest, IL

5. Abbott Laboratories, Chicago, IL

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