Idiopathic mucosal lesions of the arytenoid cartilages of 21 Thoroughbred yearlings: 1997–2001

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Summary

Reasons for performing study: Mucosal ulcers and, occasionally, small granulomas on the axial surface of one or both arytenoid cartilages have been found in TB yearlings presented for post sale endoscopic examination.

Objectives: To determine the incidence, endoscopic characteristics and outcome of a group of Thoroughbred yearlings affected with mucosal ulcers and granulomas of the arytenoid cartilage.

Hypothesis: The incidence of mucosal ulceration of the arytenoid cartilages of yearling Thoroughbreds is relatively high compared to other upper airway abnormalities; and that the majority of mucosal ulcers heal uneventfully, although a small percentage may progress to a granuloma and, less commonly, to arytenoid chondropathy.

Methods: The findings of post sale, upper airway endoscopic examinations of 3312 Thoroughbred yearlings, during a 5 year period, were reviewed, including those abnormalities listed in the conditions of sale and others not listed but considered likely to cause airway obstruction. Information obtained from the medical record of horses that had mucosal ulceration or granuloma of the arytenoid cartilage included the location and size of the lesion(s), sex of the affected horse and the presence and nature of other concurrent abnormalities of the upper portion of the respiratory tract. Additional information included treatment and results of follow-up, endoscopic examination by the authors or attending veterinarian.

Results: Mucosal lesions were seen in 0.63% of yearlings evaluated, which represented the most common, documented condition of the upper portion of the respiratory tract. The mucosal ulcers of 15 of 19 horses were considered to have healed without complication during follow-up examination; one of the 19 horses was lost to follow-up. Two horses affected with bilateral, arytenoid mucosal ulceration developed a granuloma at each site of ulceration. One horse developed a granuloma at a site of ulceration and, subsequently, arytenoid chondropathy.

Conclusions: Arytenoid mucosal ulceration in sales yearlings was a relatively commonly encountered abnormality and a small percentage progressed to granuloma or chondropathy.

Potential relevance: The mucosa of the arytenoid cartilage, particularly at the rostral margin of the vocal process, should be examined carefully during endoscopic examination of the upper portion of the respiratory tract of Thoroughbred yearlings presented for sale. Because a small percentage of mucosal ulcers may progress to granuloma or, less commonly, chondropathy, identification of mucosal ulcers of the arytenoid cartilage seen during post sale, endoscopic examination warrants notification to the purchaser and sales company. Medical therapy of affected horses should be considered and follow-up endoscopic examination performed to determine if the lesion has healed.

Introduction

Abnormalities of the upper respiratory tract of Thoroughbred yearlings are commonly identified during pre- or post sale endoscopic examination (Embertson 1998; Stick *et al.* 2001). Identification of some performance-limiting abnormalities during post sale endoscopic examination affords the buyer the opportunity to negate a purchase under conditions of sale. Abnormalities of the upper portion of the respiratory tract, seen during endoscopic examinations that are not specified in the conditions of sale, do not, without negotiation, afford the buyer the same privilege. Veterinarians, therefore, play an important role in informing sales companies of upper respiratory conditions, encountered during post sales examination, that could result in obstruction of the airway during exercise.

Reported abnormalities of the upper respiratory tract of Thoroughbred yearlings observed during endoscopic examination include deformation of the nasal septum and conchae, severe pharyngeal lymphoid hyperplasia, permanent and intermittent dorsal displacement of the soft palate, cleft palate, rostral displacement of the palatopharyngeal arch, aryepiglottic fold entrapment, subepiglottic cyst, epiglottic hypoplasia, recurrent laryngeal neuropathy and arytenoid chondropathy (Embertson 1998; Pierce *et al.* 2001; Stick *et al.* 2001).

Reported diseases of the arytenoid cartilage include chondritis (Haynes *et al.* 1980); chondroma (Trotter *et al.* 1981); hypertrophic ossification (Shapiro *et al.* 1979); intralaryngeal granulomas (Hay and Tulleners 1993; Stick *et al.* 1999); small reddened areas of unknown significance on the corniculate process or adjacent to the vocal process (Embertson 1998); and small vesicles and ulceration on the medial aspect of the cartilage (Arthur 1990).

Fig 1: Mucosal ulceration on the rostral margin of both arytenoid cartilages, just above the dorsal attachment of the vocal cords.
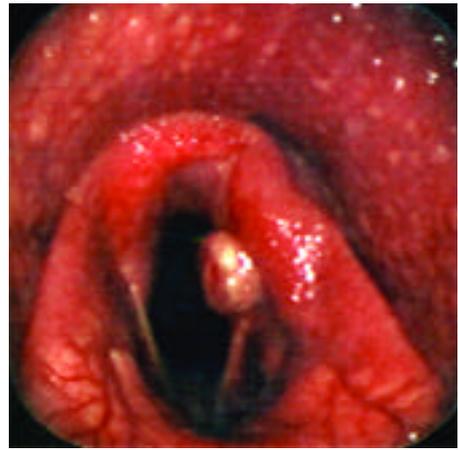

Fig 3: Granuloma and severe chondropathy of the left arytenoid cartilage.
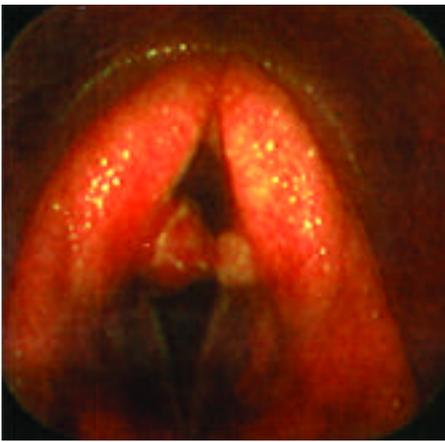

Fig 2: Granuloma on the rostral margin of both arytenoid cartilages, just above the dorsal attachment of the vocal cords.

Fig 4: Granulomas that developed at sites of ulceration seen in Figure 1.

The aims of this retrospective study were to determine the incidence and endoscopic characteristics of mucosal ulcers and granulomas of the arytenoid cartilages seen during post sale, endoscopic examination of Thoroughbred yearlings and to determine the outcome of affected horses.

Materials and methods

The results of post sale, endoscopic examination of the upper portion of the respiratory tract of 3312 Thoroughbred yearlings, examined at 13 major sales in Australia, during a 5 year period (January 1997 to April 2001), by 8 veterinarians from the Randwick Equine Centre, were reviewed. Each horse was examined at the sales complex with its nose twitched and with a fibreoptic endoscope (FC-34FX)[1] inserted into the nasopharynx via the right nasal passage; the trachea was not routinely examined. If an abnormality was noted, the examination was repeated using a videoendoscope (EPM-3500)[1]. Video recordings and photographs of lesions were acquired and abnormalities recorded. All lesions of the arytenoid cartilages were observed endoscopically by the second author (JML).

A mucosal ulcer of the arytenoid cartilage was defined as a circular loss of substance of the mucosa on the luminal surface of the arytenoid cartilage, with or without surrounding inflammation and with no gross deformity of the underlying cartilage. A granuloma of the arytenoid cartilage was defined as a round or oval mass, with an irregular surface, that had the gross endoscopic appearance of granulation tissue, with or without gross deformity of the underlying cartilage. Arytenoid chondritis was defined as inflammation with deformation of the arytenoid cartilage(s) with or without the presence of a localised granuloma. Abnormalities recorded during endoscopic examination of the upper portion of the respiratory tract included those abnormalities listed in the conditions of sale and other abnormalities not listed but considered capable of resulting in obstruction of the airway. Information obtained from the medical record of horses that had mucosal ulceration or granuloma of the arytenoid cartilage included the location and size of the lesion(s), sex of the affected horse and the presence and nature of other concurrent abnormalities of the upper portion of the respiratory tract. Additional information included treatment and results of follow-up endoscopic examination by the authors or attending veterinarian.

Owners of horses with an arytenoid mucosal lesion were instructed to have their horse re-examined endoscopically 10–14 days after initiation of medical therapy to determine if the lesion had healed, or if further treatment was necessary. Results of follow-up endoscopic examination were obtained from the initial examining veterinarian or from the attending veterinarian.

Results

Under the conditions of sale at all 13 major sales, during which the horses were examined, the following abnormalities of the upper portion of the respiratory tract allowed the purchaser to return the yearling to the vendor: recurrent laryngeal neuropathy (*grade 4* laryngeal function: Rakestraw *et al.* 1991), rostral displacement of the palatopharyngeal arch, aryepiglottic fold entrapment, permanent dorsal displacement of the soft palate, arytenoid chondropathy, subepiglottic cyst and cleft palate.

Abnormalities listed in the conditions of sale that were identified in the 3312 Thoroughbred yearlings during endoscopic examination of the upper portion of the respiratory tract included: *grade 4* laryngeal function (16 horses; 0.48%); arytenoid chondropathy (7 horses; 0.21 %); aryepiglottic fold entrapment (4 horses; 0.12%); subepiglottic cyst (2 horses; 0.06%); and permanent dorsal displacement of the soft palate (1 horse; 0.03%).

Other abnormalities identified during endoscopic examination not listed in the conditions of sale reported to the sales company included: arytenoid mucosal lesions (21 horses; 0.63%); aryepiglottic fold abscess (2 horses; 0.06%); retropharyngeal abscess (1 horse; 0.03%); and paranasal conchal deformity (1 horse; 0.03%).

Of the 21 horses (0.63%) with mucosal lesions (i.e., ulceration and/or granuloma) of one or both arytenoid cartilages, 19 (0.57%) had mucosal ulceration only, of which 13 were bilateral. One horse (0.03%) had bilateral granulomas and one horse (0.03%) had a granuloma on one arytenoid cartilage and a mucosal ulcer on the contralateral arytenoid cartilage.

Mucosal ulcers were circular and ranged in diameter from approximately 2–6 mm (Fig 1). Mucosal lesions were located consistently at the rostral margin of one or both arytenoid cartilages, just above the dorsal attachment of the vocal cord and were surrounded typically by a zone of erythema. One horse with bilateral arytenoid mucosal ulceration also had left, idiopathic, recurrent, laryngeal neuropathy (*grade 4* laryngeal function). Intraluminal arytenoid granulomas were raised, red, spherical lesions, which ranged in diameter from approximately 4–10 mm (Fig 2). The arytenoid cartilages of both horses affected with granuloma were not enlarged and were able to abduct fully and symmetrically.

Of the 21 horses in which arytenoid mucosal lesions were identified, 6 were male and 15 female. The affected yearlings were presented for sale from 15 individual farms, but 7 of the affected horses originated from one farm, although not all in the same year.

Treatment

Eighteen of the 19 horses with arytenoid mucosal ulceration were treated with antimicrobial and anti-inflammatory drugs and confined to a small yard. This same treatment was recommended for one horse that was lost to follow-up. The duration of medical therapy was variable (mean ± s.d. 11 ± 7.89 days; median 7 days). Eighteen horses with mucosal ulceration received procaine penicillin G (22,000 iu/kg bwt, i.m.) b.i.d., for 5–14 days and 14 of these horses also received gentamicin sulphate (6.6 mg/kg bwt, i.v.), once daily for 5–14 days. Four horses received trimethoprim-sulpha (16 mg/kg bwt, *per os*), b.i.d., for 14 days; 3 of these 4 horses had received an initial course of penicillin and gentamicin sulphate and, therefore, antimicrobial treatment with trimethoprim-sulpha was used as a primary treatment for only one

horse. Eighteen horses received phenylbutazone (2.2 mg/kg bwt, *per os*), b.i.d., for 5–14 days.

All of the horses diagnosed with arytenoid mucosal ulcer, for which follow-up was available (18 horses), received lavage of the larynx b.i.d. with 10 ml of a stock solution composed of prednisone (4%; 1 g); nitrofurazone (0.2%; 375 ml); dimethylsulphoxide (10%; 125 ml); and glycerine (100%; 500 ml). The solution was administered via a 10-F, dog urinary catheter inserted up a nasal passage. Duration of this treatment ranged 5–28 days.

Follow-up

Information regarding the follow-up endoscopic appearance of the larynx was obtained for 20 of the 21 horses. One horse with bilateral ulceration and concurrent, left recurrent laryngeal neuropathy was lost to follow-up. Results of follow-up, endoscopic examination of the larynx were available for 18 of the 19 horses with mucosal ulceration. The mucosal ulcerations of 15 horses (83%) were observed to have healed completely during subsequent endoscopic examination of the larynx. Follow-up examination was performed between 5 and 42 days after diagnosis, (mean ± s.d. 16.79 ± 10.52 days; median 14 days).

Healed mucosal lesions were characterised by complete mucosal regeneration or a small, flat, white scar without detectable alteration in shape or size of the underlying cartilage. Function of the affected arytenoid cartilages was considered *grade 2* (Rakestraw *et al.* 1991) or better. Three horses with mucosal ulceration developed an intraluminal granuloma at each site of ulceration, despite medical therapy and one of these horses developed severe arytenoid chondropathy, as well as a granuloma (Fig 3). Of the 5 horses with intraluminal arytenoid granulomas, 3 were affected bilaterally and 2 were affected unilaterally. Except for the horse that developed chondropathy, the arytenoid cartilages of the horses with an intraluminal granuloma appeared to be morphologically and functionally normal i.e., capable of achieving full abduction.

A mucosal ulcer of one horse had healed at 14 days, but the appearance of a contralateral granuloma had not changed. This horse had been treated for 7 days with procaine penicillin G (22,000 iu/kg bwt, i.m., b.i.d.), gentamicin sulphate (6.6 mg/kg bwt, i.v., s.i.d.) and phenylbutazone (2.2 mg/kg bwt, *per os*, b.i.d.). Exuberant tissue was trimmed to the level of the mucosal surface transendoscopically with a diode laser (Diomed 25 25W Surgical laser)[2], performed as described previously (Hay and Tulleners 1993), with the horse standing and sedated and the larynx anaesthetised with topically applied local anaesthetic solution. The mucosal defect was seen to have healed 4 weeks after surgery, but the area beneath the defect appeared to be slightly thickened. Laryngeal function of this horse was *grade 2* (Rakestraw *et al.* 1991).

Two horses with bilateral mucosal ulceration of the arytenoid cartilage had developed bilateral granuloma at the sites of ulceration when the horses were examined endoscopically 14 days later. One of these horses had initially been treated for 14 days with trimethoprim-sulpha (16 mg/kg bwt, *per os*, b.i.d.), phenylbutazone (2.2 mg/kg bwt, *per os*, b.i.d.) and throat lavage (10 ml, intranasally, b.i.d.) (Fig 4). The other horse had initially been treated for 7 days with procaine penicillin G (22,000 iu/kg bwt, i.m., b.i.d.), gentamicin sulphate (6.6 mg/kg bwt, i.v., once daily), phenylbutazone (2.2 mg/kg bwt, *per os*, b.i.d.) and throat lavage (10 ml, intranasally, b.i.d.). The protruding tissue in these 2 horses was excised via a laryngotomy, with the horse anaesthetised, using

cutting-mode electrocautery (Valleylab SSE2K)[3].

Bilateral granulomas of the arytenoid cartilage of one horse, discovered during the post sale, endoscopic examination, were excised to the mucosal surface transendoscopically with a diode laser[2], when the granulomas failed to resolve 14 days after initiation of medical therapy (i.e. administration of procaine penicillin G [22,000 iu/kg bwt, i.m., b.i.d.], phenylbutazone [2.2 mg/kg bwt, *per os*, b.i.d.] and throat lavage [10 ml, intranasally, b.i.d.]). These 3 horses were treated for 7 days after surgery with procaine penicillin G (22,000 iu/kg bwt, i.m., b.i.d.), gentamicin sulphate (6.6 mg/kg bwt, i.v., s.i.d.), phenylbutazone (2.2 mg/kg bwt, *per os*, b.i.d.) and throat lavage (10 ml, intranasally, b.i.d.).

When the larynges of the 4 horses treated with local excision of intraluminal granulation tissue, were examined endoscopically 4 weeks post operatively, all lesions had healed and were replaced with a small scar. Both arytenoid cartilages of 2 horses, however, were mildly enlarged, but each horse was capable of achieving full abduction.

The horse that developed chondropathy underwent a partial arytenoidectomy, performed as described previously (Lumsden and Stick 1998). The excised tissue was not examined histologically. Of the 4 horses that underwent surgical treatment to excise intralaryngeal granulation tissue, all had completed 3 or more race starts at the time of writing. The horse that underwent partial arytenoidectomy had raced 9 times, had won twice, and been placed 3 times.

Discussion

The aims of this retrospective study were to investigate the incidence and outcome of Thoroughbred yearlings with mucosal lesions of the arytenoid cartilage. Studies documenting results of endoscopic examinations of the upper portion of the respiratory tract of Thoroughbred yearlings at sales make no mention of mucosal lesions of the arytenoid cartilage (Embertson 1998; Pierce 2001; Stick *et al.* 2001). In our study, mucosal lesions were seen in 0.63% of yearlings evaluated and represented the most common, documented condition of the upper portion of the respiratory tract. Other abnormalities considered unlikely to result in respiratory obstruction, e.g. intermittent DDSP and immature-appearing epiglottis (Stick *et al.* 2001) were not routinely recorded and therefore, may have been more prevalent than ulceration.

Although medical therapy may have prevented progression of mucosal ulcers to granuloma in some horses, bilateral mucosal ulcers of 2 horses progressed to granulomas (Fig 4). In one horse, ulceration progressed to chondropathy. Because the aetiology of mucosal lesions was not determined and no untreated horses were evaluated, the role of antimicrobial and anti-inflammatory therapy in resolving the mucosal lesions was difficult to evaluate. Mucosal ulcers were not sampled for bacterial nor viral culture or evaluated histologically because of difficulty in obtaining samples. Future studies evaluating larger numbers of treated and untreated horses affected with mucosal ulceration may elucidate the role of antimicrobial therapy in facilitating uncomplicated healing.

Disease of the arytenoid cartilage or its overlying mucosa has been reported to occur in man (Jackson and Jackson 1935), cattle (Jensen *et al.* 1980), sheep (Lane *et al.* 1987) and horses (Haynes *et al.* 1980). Mucosal erosions of the arytenoid cartilages of feedlot cattle have been reported to result from acute mucositis caused by mixed infections of *Pasturella*, *Haemophilus*, *Mycoplasma* and

unidentified viruses (Jensen *et al.* 1980). In young cattle, infected naturally and experimentally with *Haemophilus sp.*, the lesion may develop from small infarcts caused by infected and thrombosed subtending vessels (Jensen *et al.* 1980).

Cattle, soon after entering a feedlot, frequently contract infection of the upper portion of the respiratory tract from mixed bacterial and viral infections (Jensen *et al.* 1980), causing the mucous membrane of the larynx to become oedematous and haemorrhagic. Infection increases the volume of respiratory secretions and accelerates coughing and swallowing, both of which may accelerate the rate and force of laryngeal closure. This forceful closure erodes the oedematous/swollen membrane over the medial aspect of the arytenoid cartilages, (i.e. points of high pressure and first contact), producing contact ulcers.

Clinical and experimental studies investigating the aetiology of laryngeal ulcers and granulomas of human subjects have found that violent, clashing trauma of the arytenoid cartilages predisposes to development of mucosal lesions (Jackson and Jackson 1935; Von Leden and Moore 1960). Excessive vocalisation in man is a well recognised, precipitating factor in the development of laryngeal mucosal ulcers (Jackson and Jackson 1935; Ward *et al.* 1960; Feder and Michell 1984) and horses that vocalise excessively may be more predisposed to development and progression of lesions. The lesions found in our study were consistently located at the rostral margin of the arytenoid cartilage, just above the attachment of the vocal cord and mucosal lesions of the arytenoid cartilage of human subjects are found consistently in this same location (Benjamin and Roche 1993). For this reason, horses affected with mucosal lesions should receive restricted exercise to avoid further irritation from rapid airflow and violent clashing of the already damaged mucosa on the medial aspect of their arytenoid cartilages, which could occur during heavy exercise.

An infectious agent, initiating mucositis, in concert with forceful closure of the arytenoid cartilages, may be a significant factor in the aetiopathogenesis of mucosal ulceration and granuloma formation of the arytenoid cartilage of horses. Epidemiological studies may be useful in finding common aetiological factors involved in the formation of ulcers of the arytenoid cartilage. The true incidence of the condition among Thoroughbred yearlings at individual farms was not determined, because horses not consigned to the sale were not examined endoscopically

Correlation between mucosal ulcers of the arytenoid cartilage and recurrent laryngeal neuropathy seems unlikely. Montgomery (1981) suggested that left, recurrent laryngeal neuropathy, in conjunction with continued athletic activity, could produce a mucosal lesion of one or both arytenoid cartilages, which in turn, could lead to chondropathy by promoting contact between them. An association between recurrent laryngeal neuropathy and mucosal lesions seems unlikely because only one horse in our study with mucosal ulceration had concurrent, left recurrent laryngeal neuropathy (i.e. *grade 4* laryngeal function) and because mucosal ulceration is a rarely reported condition of yearlings and older subjects affected with recurrent laryngeal neuropathy.

Trauma to the laryngeal area from repeated endotracheal or nasogastric intubation or endoscopic examination seems unlikely to have played a role in the aetiology of arytenoid cartilage ulceration. If trauma, caused by passage of a tube into the laryngeal lumen, had played a role in the development of the lesions, we would have expected the lesions to be located more rostrally, on the corniculate process. Even though most yearlings

undergo pre-sale, endoscopic examination of the upper portion of the respiratory tract, this examination does not routinely include examination of the trachea.

Purchase of horses affected with granuloma of the arytenoid cartilage should be considered carefully, because a granulomatous mass arising from the axial surface of one or both of the arytenoid cartilages may result in partial exercise intolerance, even when the underlying cartilage has normal structure and function (Hay and Tulleners 1993). Endoscopic confirmation of cartilaginous disease beneath a mucosal ulcer or granuloma is difficult in the absence of grossly detectable cartilaginous enlargement. We speculate, as did Arthur (1990), that ulceration of the medial aspect of the arytenoid may sometimes precede the development of chondropathy.

Epithelial regeneration of a superficial ulcer, without the formation of granulation tissue, begins at the basement membrane, when this layer is intact (Bradley 1997). A laryngeal ulcer may progress to a granuloma, despite medical therapy, if the basement membrane is destroyed. Healing, in this instance, is considerably slower and requires formation of granulation tissue, which first forms at the edge of the ulcerated tissue (Bradley 1997). The basement membrane may be destroyed, despite medical therapy, allowing bacteria access into the underlying perichondrium and cartilage, resulting in the development of septic chondropathy. One horse with a granuloma developed chondropathy of the arytenoid cartilage and we believe that the chondropathy resulted from extension of the disease process into the underlying perichondrium and cartilage.

Failure of medical therapy to heal granulomas in man warrants surgical excision of the lesion (Bradley 1997). If a granuloma is diagnosed early, before infection extends into the arytenoid cartilage, excision of the granuloma may be beneficial in returning horses to athletic activity (Hay and Tulleners 1993). The aims of excision of intraluminal granulomatous projections of the arytenoid cartilage should be to avoid formation of a 'kissing lesion' on the mucosa of the contralateral cartilage, to facilitate epithelialisation and to improve the cross-sectional area of the *rima glottidis.*

Granulation tissue should be excised when it is protuberant or when the lesion has failed to resolve with medical therapy. Intralaryngeal granulomas of horses can be excised through a laryngotomy, with the horse anaesthetised (Haynes *et al.* 1980) or standing (Sullins 2001). Granulomas can also be excised with the horse standing, using an Nd:Yag laser (Hay and Tulleners 1993). When removing granulation tissue, normal mucosa should not be removed and the perichondrium should not be damaged, but this may be difficult to achieve (Benjamin and Roche 1993; Bradley 1997).

Lesions of 2 of the 4 horses treated by excision of intra-laryngeal granulomatous tissue healed without resulting in cartilaginous thickening. Even though the lesions of the other 2 horses healed without compromised abduction, the arytenoid cartilages of these horses appeared slightly enlarged. This enlargement could have been caused by thickened mucosa, submucosal fibrosis or by thickened cartilage caused by damage to the perichondrium, either from disease or from surgical trauma. The arytenoid cartilages of these 2 horses remained enlarged but the horses did not develop clinical or endoscopic evidence of chondropathy, during the period of follow-up.

Although the aetiology of the laryngeal mucosal lesions was not determined, treatment of horses in our study was directed at resolving the acute inflammation by administering antimicrobial and anti-inflammatory medication. The base of laryngeal mucosal

ulcers of cattle contains bacteria (Jensen *et al.* 1980) and, if the same is true of laryngeal, mucosal ulcers of the horses in our study, then antimicrobial therapy may have been effective in eliminating bacteria from the base of the mucosal ulcers.

This study identifies arytenoid mucosal ulcers as a relatively common abnormality, when the incidence of ulceration is compared to the incidence of other abnormalities, encountered during post sale endoscopic examination of the upper portion of the respiratory tract of Thoroughbred yearlings. The development of granulomas at the site of ulceration in 2 (10%) and chondropathy in one (5%) of the affected horses in this study suggests that laryngeal ulcers are a significant finding. For this reason, we recommend that the mucosa of the arytenoid cartilages, particularly at the rostral margin of the vocal process, as well as the function of arytenoid cartilages, be carefully examined during endoscopic examination of the upper portion of the respiratory tract. The propensity for a small percentage of mucosal ulcers to progress to granuloma or chondropathy warrants notification of the condition, consideration of medical therapy of the affected horse and repeat endoscopic examination to determine if the lesion has healed.

Acknowledgements

Manufacturers'addresses

References

Arthur, R.M. (1990) Respiratory problems in the racehorse. *Vet. Clin. N. Am.: Equine Pract.* **5**, 187.

Benjamin, B. and Roche, J. (1993) Vocal granuloma, including sclerosis of the arytenoid cartilage: radiographic findings. *Ann. Otol. Rhinol. Laryngol.* **102**, 756-760.

Bradley, P.J. (1997) Arytenoid granuloma. Editorial review. *J. Laryngol. Otol.* **111**, 801-803.

Embertson, R.M. (1998) Evaluation of the upper respiratory tract in weanlings and yearlings. In: *Current Techniques in Equine Surgery and Lameness*, 2nd edn., Eds: N.A. White and J.N. Moore, W.B Saunders Co., Philadelphia. p 126.

Feder, R.J. and Michell, M.J. (1984) Hyperfunctional, hyperacidic and intubational granulomas. *Arch. Otolaryngol.* **110**, 582-584.

Hay, W.P. and Tulleners, E.P. (1993) Excision of intralaryngeal tissue in 25 horses using neodymium: YAG laser (1986-1991). *Vet. Surg.* **22**, 129-134.

Haynes, P.F., Snider, T.G., McClure, J.R. and McClure, J.J. (1980) Chronic chondritis of the equine arytenoid cartilage. *J. Am. vet. med. Ass.* **177**, 1135-1142.

Jackson, C. and Jackson, C.L. (1935) Contact ulcer of the larynx. *Arch. Otolaryngol.* **22**, 1-15.

Jensen, R., Lauerman, L.H., Braddy, P.M., Horton, D.P., Flack, D.E., Cox, M.F., Einertson, N., Miller, G.K. and Rehfeld, C.E. (1980) Laryngeal contact ulcers in feedlot cattle. *Vet. Pathol.* **17**, 667-671.

Lane, J.G., Brown, P.J., Lancaster, M.L. and Todd, J.N. (1987) Laryngeal chondritis in Texel sheep. *Vet. Rec.* **121**, 81-84.

Lumsden, J.M. and Stick, J.A. (1998) Arytenoidectomy. In: *Current Techniques in Equine Surgery and Lameness*, 2nd edn., Eds: N.AWhite and J.N. Moore, W.B Saunders Co., Philadelphia. pp 145-149.

Montgomery, T. (1981) Clinical classification of chronic pharyngitis and other pharyngolaryngeal pathology in the horse. *Equine Pract.* **6**, 26-31.

Pierce, S.W. (2001) Correlation of racing performance to yearling endoscopic evaluation. *Proc. Am. Ass. equine Practnrs*. **47**, 113-114.

Rakestraw, P., Hackett, R.P., Ducharme, N.G., Nielan, G.J and Erb, H.N. (1991) Arytenoid cartilage movement in resting and exercising horses. *Vet. Surg*. **20**, 122-127.

Shapiro, J., White, N.A., Schlafer, D.H. and Rowland, G.N. (1979) Hypertrophic ossification of the laryngeal cartilages of the horse. *J. equine Med. Surg*. **3**, 370-374.

Stick, J.A., Tulleners, E.P., Robertson, J.T. and Holcombe, S.J. (1999) Larynx. In: *Equine Surgery*, 2nd edn., Eds: J.A. Auer and J.A. Stick, W.B. Saunders Co., Philadelphia. p 366.

Stick, J.A., Peloso, J.G., Morehead, J.P., Lloyd, J., Eberhart, S., Padungtod, P. and

Derksen, F.J. (2001) Endoscopic assessment of airway function as a predictor of racing performance in Thoroughbred yearlings. 427 cases (1997-2000) *J. Am. vet. Am. Ass*. **219**, 962-966.

Sullins, K.E. (2001) Minimally invasive laser treatment of arytenoid chondritis in five horses. *Proc. Am. Ass. equine Practnrs.* **47**, 120-122.

Trotter, G.W., Aanes, W.A. and Snyder, S.P. (1981) Laryngeal chondroma in a horse. *J. Am. vet. med. Ass*. **178**, 829.

Von Leden, H. and Moore, P. (1960) Contact ulcer of the larynx. Experimental observations. *Arch. Otolaryngol.* **72**, 746-752.

Ward, P.H., Zwitman, D., Hansen, D. and Birce, G. (1960) Contact ulcers and granulomas of the larynx. New insights into their aetiology as a basis for rational treatment. *Otolaryngol. Head Neck Surg.* **88,** 262-269.