Diseases of the guttural pouches

Joanne Hardy, DVM, PhD a,*, Renée Léveillé, DVM b

a Department of Veterinary Clinical Sciences, The Ohio State University, 601 Vernon L. Tharp Street, Columbus, OH 43210, USA
b Veterinary Specialty Center, Buffalo Grove, IL 60089, USA

Anatomy

Guttural pouches are large diverticula of the eustachian tubes that connect the pharynx to the middle ear. They are present in perissodactyls, such as equids, tapirs, some species of rhinoceros (except for the white rhinoceros), some bats, a South American forest mouse, and hyraxes [1–3]. Each pouch has a capacity of approximately 300 to 500 mL and is lined with a pseudostratified ciliated epithelium containing goblet cells [4]. Several mucous glands as well as lymphoid nodules are present in the young horse. Each guttural pouch is separated into a medial and lateral compartment by the ipsilateral stylohyoid bone, over which each pouch is draped. The epithelium overlies several vascular, neural, and lymphoid structures, and knowledge of these structures is important in understanding the clinical signs of guttural pouch disease. The medial compartment, the larger one of the two, is in contact with the internal carotid artery (ICA); the cranial cervical ganglion; the vagus; glossopharyngeal, hypoglossal, and spinal accessory nerves; and sympathetic nerves. Cranial nerves IX, X, XI, and XII are clearly visible under a mucosal fold. Ventrally, the medial compartment overlies the retropharyngeal lymph nodes, the pharyngeal branch of the vagus, and the recurrent laryngeal nerve, with this last structure being located in a mucosal fold (Fig. 1). The external carotid artery (ECA) can be seen coursing in a ventrodorsal direction on the lateral wall of the medial compartment (Fig. 2). The lateral compartment is approximately one third of the capacity of the medial compartment and laterally overlies the digastricus muscle and the parotid and mandibular glands. These structures limit lateral expansion of the pouch such that distention principally affects the medial compartment [5].
The maxillary artery (MA) can be seen clearly coursing in the lateral compartment, where it gives off the caudal auricular artery and, more dorsally, the superficial temporal artery (Fig. 3). The stylohyoid bone travels in a caudodorsal direction to the temporohyoid joint, and the most distal opening of the eustachian tube can be seen just lateral to this joint. The auricular cartilage is in close contact to the dorsolateral aspect of the guttural pouch such that movement of the ear displaces the auricular cartilage on endoscopy. The facial and vestibulocochlear nerves are in close proximity to the lateral aspect of the temporostylohyoid joint (Fig. 4).

The pharyngeal openings of the pouches are located in the dorsolateral aspect of the pharynx and are identified as oblique slits located rostral and ventral to the pharyngeal recess. These openings are funnel shaped, with the small end of the funnel opening up into the guttural pouch. One comparative study of domestic and wild species documented that the equine pharyngeal openings of the eustachian tubes were the largest and most rostral [9]. The medial lamina of each opening is composed of fibrocartilage directed in a rostroventral-to-caudodorsal direction. The guttural pouches are apposed at the median septum, except dorsally, where they are separated by the rectus capitis and longus capitis muscles. The caudal extent of each guttural pouch is in close proximity to the atlantoaxial articulation, ventral to the attachment of the longus colli muscle [5]. The most rostral aspect of the septum is localized just beneath the mucosa of the pharyngeal recess.

Fig. 1. Endoscopy of the medial compartment of the right guttural pouch showing the internal carotid artery (arrow) and cranial nerves IX, X, XI, and XII (arrowhead).
such that on endoscopy, each guttural pouch can be seen expanding on respiration.

**Function**

Many functions have been attributed to the guttural pouches, including pressure equilibration across the tympanic membrane, contribution to air warming, a resonating chamber for the equine whinny, and a flotation device [6]. More recently, a brain-cooling role has been attributed to the guttural pouches based on measurement of lower arterial temperatures in the cerebral compared with the cardiac side of the ICA [7,8]. Based on experiments performed in cadavers, one study concluded that regulation of guttural pouch opening was based on active and passive processes and was mediated through the actions of the levator and tensor veli palatini and pterygopharyngeus muscles and by contraction of the palatopharyngeus muscle. Passive opening of the auditory tube involved a reduction in tone of the stylopharyngeus and pterygopharyngeus muscles accompanied by increased inspiratory pressure [9]. Although previously reported as filling on expiration, this latter study demonstrated that guttural pouch filling occurs on inspiration [9]. Importantly, the major blood supply to the brain of horses is the basilar artery such that occlusion of both ICAs or of the common...
Fig. 3. Endoscopy of the lateral compartment illustrating the course of the maxillary artery (arrow) and the caudal auricular artery (arrowhead).

Fig. 4. View of the bony skull of a horse showing the acoustic meatus and stylomastoid foramen, where the facial and vestibulocochlear nerves exit the skull.
carotid artery (CCA) does not lead to cerebral ischemia. Because of retrograde blood flow from the contralateral ICA as well as from the basilar artery, occlusion of the CCA does not significantly alter blood pressure in the ICA. This is an important finding, because emergency ligation of the CCA would not prevent hemorrhage from guttural pouch mycosis [10].

Examination

The guttural pouches are examined by external palpation, endoscopy, and radiography. Enlarged guttural pouches, particularly in cases of tympany, can be palpated externally. Because the guttural pouch lies in close contact with the auricular cartilage, palpation of the base of the ear can be painful in cases of guttural pouch disease.

Guttural pouch endoscopy yields the most information regarding guttural pouch disease. Endoscopy can occasionally initiate bleeding in cases of guttural pouch mycosis and thus should be performed with caution if this condition is suspected. If this is the case, particularly if there is a history of recent epistaxis, preparation for immediate surgical intervention should be made before performing endoscopy. The flexible endoscope can be introduced in the pouch using the biopsy channel and instrument, or the pharyngeal opening can be pried open using a Chambers catheter. The biopsy forceps are introduced into the biopsy channel of the endoscope. On most endoscopes, the biopsy channel is located in an eccentric location on the end of the scope such that the endoscope has to be manipulated to open the pouch maximally (Fig. 5). The endoscope is manipulated to maintain the biopsy forceps as close as possible to the lateral wall of the pharynx until successful insertion into the guttural pouch is achieved. The endoscope is then rotated 180° to maximally open the medial lamina of the guttural pouch opening and is then inserted slowly, allowing it to follow the forceps. For the left pouch, the endoscope has to be turned 180° (upside down) to insert the biopsy forceps and turned back to a normal vertical axis to insert the scope. For the right pouch, the forceps are inserted with the endoscope upright, and they then need to be turned clockwise 180° to allow opening of the flap and entry into the pouch. The endoscope is inserted into each ipsilateral nostril for guttural pouch endoscopy. With practice, both pouches can be entered in this manner with the endoscope in the same nostril. Alternatively, particularly if there is scarring of the medial lamina, a mare’s Chambers catheter can be inserted in the nostril opposite the one used for endoscope insertion so as to allow prying open the pharyngeal lamina for endoscope insertion (Fig. 6).

Before examination of the guttural pouch, a complete examination of the nasal passages, pharynx, and larynx is completed. Guttural pouch disease can be accompanied by dorsal collapse of the pharyngeal wall from empyema or tympany, laryngeal hemiplegia, or dorsal displacement of the
soft palate. Occasionally, a fistula from the guttural pouch to the pharyngeal recess can be seen, particularly with guttural pouch mycosis. Exudate or blood exiting from the guttural pouch should be noted. It should also be recognized that the splatter of blood can seem to originate from the guttural pouch with severe epistaxis from another origin.

On endoscopic examination of the pouch, the presence of exudate, blood, and intra- or extraluminal masses should be noted. Blood can originate from longus capitis rupture or from guttural pouch mycosis. With longus capitis rupture, a hematoma, sometimes with frank blood within the pouch, can be seen in the dorsal aspect of the median septum (see section on longus capitis rupture). With guttural pouch mycosis, blood can range from complete obstruction of the field of view to a small punctate blood clot on one of the arteries (see section on guttural pouch mycosis). Intraluminal masses are usually associated with the presence of chondroids. Cysts have also been described originating form the pouch. Extrapulmonary masses can be associated with abscesses or neoplasia. Retropharyngeal abscesses can develop on the ventral aspect of the pouch and can be seen bulging under the mucosa. The neoplastic masses most commonly described are melanomas, but squamous
cell carcinoma, hemangiosarcomas, and fibromas have been reported. Raised plaques covering the mucosa of the guttural pouch are an indication of guttural pouch mycosis. They have a wide range of appearance endoscopically, ranging from a small punctate hemorrhage on an artery to widespread plaques overlying the entire pouch. When discrete, the location of the plaque is important to note because it indicates which artery is involved. Although some plaques appear to be located on seemingly non-vascular areas, many of those acquire a newly formed blood supply that can subsequently be the cause of severe hemorrhage. Therefore, if there is a sign of previous hemorrhage, any fungal-like plaque should not be sampled or biopsied.

Guttural pouch catheterization for local treatment purposes can be performed blindly or with the aid of an endoscope. With practice, blind catheterization can be performed routinely. The landmarks are the middle of the ipsilateral nostril and the medial canthus of the eye. When the catheter reaches that limit, it is rotated 180° toward lateral so as to lift and open the fibrocartilaginous opening. Correct localization is identified by complete insertion of the catheter, which cannot be done if the pouch has

Fig. 6. Endoscopy of the pharynx showing insertion of a Chambers catheter to spread the medial lamina of the pharyngeal opening to the guttural pouch so as to facilitate entry of the endoscope.
not been entered, or by endoscopic observation. When a single catheterization is needed, a Chambers catheter or a uterine pipette with an angle of 60° can be used (see Fig. 6). When chronic catheterization is needed for daily flushing, a commercially made guttural pouch catheter (Cook Veterinary Projects, Bloomington, IN; Mila International, Florence, KY) can be used. Alternatively, one can be fashioned using a polypropylene dog urinary catheter, which is coiled under heat (hot water) and allowed to cool. The catheter is then straightened with the aid of a wire to facilitate insertion; once in the pouch, the wire is removed and the catheter resumes its coiled configuration, which helps to maintain it in the pouch. A Foley catheter can also be used, but it should be advanced until the end is completely in the pouch before distention of the balloon. Distention of the balloon within the funnel of the pharyngeal opening could cause pressure necrosis. In larger horses, standard Foley catheters are not long enough to reach the guttural pouch.

Radiography

The air-filled guttural pouches provide an ideal contrast material for radiographic imaging. Lateral projections provide information about the dimensions and content of the guttural pouches. Fluid accumulation results in an air-fluid interface, whereas masses (eg, hematoma, chondroids) show up as radiopaque structures. Excessive air filling, such as that in tympany, can result in increased limits to the affected guttural pouch, the limits of which can extend beyond the second cervical vertebra. Masses caudal to and impinging on the guttural pouch should be noted. A dorsoventral or ventrodorsal projection is best used to image the stylohyoid bones.

Computed tomography

Computed tomography, when available, can provide an alternate imaging modality for the diagnosis of guttural pouch diseases [11–13]. This imaging method may be most beneficial for imaging of the stylohyoid bone, inner ear, and petrous temporal bone in cases of stylohyoid arthropathy.

Cytology

One study examined the cytologic findings of guttural pouch lavages performed percutaneously through Viborg’s triangle [14]. The proportion of neutrophils was an important criterion, with less than 5% neutrophils being considered normal and greater than 25% being considered abnormal. There was a high correlation between a high cytologic score and the presence of pathogenic bacteria, such as *Streptococcus equi* [15,16].
Diseases of the guttural pouches

The most common afflictions of the guttural pouches include empyema, tympany, and guttural pouch mycosis. Occasionally, neurologic disorders of the facial and vestibulocochlear nerves resulting from stylohyoid arthropathy are diagnosed with guttural pouch endoscopy. Guttural pouch mycosis and longus capitis avulsion are the most common conditions associated with guttural pouch hemorrhage. Other afflictions, including trauma, cysts, and neoplasia, are infrequently encountered.

Guttural pouch empyema

This is the most common disease of guttural pouches. It is most frequently a result of an upper airway infection, which can extend into the guttural pouch. Alternatively, retropharyngeal abscesses can drain into the ipsilateral guttural pouch, resulting in guttural pouch empyema. Upper airway viral infections can result in lymphoid hyperplasia into the pouches. Chronic guttural pouch empyema can result in scarring of the pharyngeal opening with subsequent failure to drain on the affected side.

Bacteria most commonly isolated from bacterial infections include *S equi var equisimilis* and *S equi var equi*. Because *S equi var equi* infection (strangles) is highly contagious, isolation procedures should be enforced until culture results are obtained in all cases of guttural pouch empyema.

Unilateral copious drainage is a common clinical sign of guttural pouch empyema (Fig. 7). Because of the relative rostral position of the pharyngeal opening, drainage is facilitated when the horse lowers its head. Drainage is commonly observed at rest and when the horse is eating rather than at exercise. Accompanying signs of bronchopneumonia or enlarged lymph nodes may be present. Because of the deep location of the retropharyngeal lymph nodes, retropharyngeal abscesses can be difficult to palpate externally. With chronic empyema, signs of cranial nerve involvement can be observed, such as dysphagia or laryngeal hemiplegia. Dysphagia or respiratory stridor may also result from laryngeal impingement by the abscess.

The diagnosis of guttural pouch empyema is based on unilateral nasal discharge, usually in copious volumes and unrelated to exercise but occasionally associated with cranial nerve dysfunction, most commonly, dysphagia. On clinical examination, there is unilateral discharge, or if bilateral, it is more abundant on one side. On endoscopy, there is discharge from one of the guttural pouch openings. Within the affected pouch, exudate or chondroids can be seen (Figs. 8 and 9). On rare occasions, a pharyngeal fistula has formed at the pharyngeal recess, allowing drainage. Radiographs are useful to differentiate empyema, chondroids, and retropharyngeal abscess (Fig. 10).

Treatment of guttural pouch empyema includes systemic and local therapy as well as addressing secondary complications. Systemic antibiotics
are usually recommended for two reasons: drainage of the pouch can infect the lower airways, and treatment of lymph nodes abscesses can be helped with antibiotics. If the horse is dysphagic, antibiotics are indicated to prevent or treat aspiration pneumonia. Catheterization helps in daily flushing of the affected pouch. Balanced electrolyte solutions are recommended to avoid further irritation of the pouch. Instillation of antiseptics into the pouch is not recommended, because antiseptics are usually irritating.

When chondroids are present, three options are described: surgical drainage, local drainage, or dissolution and drainage. Surgical drainage of chondroids is best performed with the horse in dorsal recumbency using a modified Whitehouse approach. Distention of the affected pouch facilitates its surgical identification. A Viborg’s triangle approach can also be used, particularly in the standing horse, but drainage of chondroids is more difficult with this approach. The surgical incisions are left to heal by second intention. Local drainage can be performed under endoscopic observation by prying open the gullet pouch opening using a Chambers catheter. Lavage is performed using high-flow fluids, either with a pressurized bag or a peristaltic pump. This method works in the presence of small
chondroids. Infusion of acetylcysteine into the pouch for the purpose of
dissolution of chondroids has also been described. In the author’s opinion,
this should be undertaken with caution, because this solution is extremely
irritating. Excessive irritation of the pouch can lead to neurologic problems.

Retropharyngeal abscesses can drain into the guttural pouch, resulting in
empyema. These abscesses can be diagnosed by endoscopy or radiography.
Compression of the larynx and upper esophageal opening can lead to
dysphagia or respiratory distress. If these signs are present, surgical drain-
age should be performed. Surgical drainage of retropharyngeal abscesses

Fig. 8. (A) Endoscopy of the guttural pouch showing a fluid line consistent with guttural pouch
empyema. (B) Lateral projection of the head of a horse with guttural pouch empyema. The
arrows point to a fluid line within the guttural pouch.
Fig. 9. (A) Endoscopy of the guttural pouch showing chondroids (*arrow*) on the floor of the medial compartment. (Courtesy of Warren Beard, DVM, The Ohio State University, Columbus, OH.) (B) Lateral projection of the guttural pouch of a horse with chondroids (*arrow*).
can be performed through a Viborg’s triangle approach. It is sometimes not possible to palpate these abscesses externally. The area is prepared aseptically and infiltrated with local anesthesia. An 18-gauge needle is inserted in the center of Viborg’s triangle and directed dorsally and cranially at an angle of approximately 45°. Aspiration with a syringe is used until purulent material is obtained, at which point, the needle is left in place and a scalpel with a number 11 blade is used to follow the needle until puncture of the abscess is obtained. The skin incision is enlarged to improve drainage, and the abscess is flushed daily with saline until drainage stops. If
Retropharyngeal abscessation is present without compression of the larynx, long-term antibiotic treatment alone can be useful to resolve the infection. Secondary complications of guttural pouch empyema include lower airway infection, dysphagia, or permanent displacement of the soft palate. If the horse is dysphagic, nutritional support may need to be provided in addition to treatment of the primary problem.

The prognosis for this condition is generally good. Stall rest for 3 weeks is generally recommended so as to allow recovery of the respiratory epithelium. Feeding should be performed on the ground so as to allow drainage, and dust should be minimized. Importantly, the guttural pouch is thought to be the predominant site for carriage of $S$ equi, so complete resolution of infection should be ensured by physical examination, guttural pouch endoscopy, or guttural pouch lavage before returning affected animals to the herd [17].

**Tympany**

Guttural pouch tympany can affect foals from birth to 1 year of age. It is presumably caused by redundant mucosa on the ventral aspect of the guttural pouch opening, which creates a one-way valve effect. Air can get into the pouch but cannot escape.

Tympany has been described as congenital, where there is excess mucosa, or, more commonly, as acquired, where upper airway inflammation results in edema of the mucosa. A malformed pharyngeal opening has also been described in association with scar tissue. Fillies are predominantly affected for unknown reasons.

Early on, the owner may report an inspiratory stridor that worsens with excitement. This is because the dorsal pharyngeal wall, being the point of least resistance, collapses first with distention (Fig. 11) [5]. As the condition progresses, external tympany caudal to the ramus of the mandible and in the region of Viborg’s triangle can be seen (Fig. 12). Severe distention can result in respiratory distress, because pharyngeal collapse obstructs the larynx. Because of the relative rigidity of the structures surrounding the lateral compartment, the distention usually affects the medial compartment. Most commonly, the condition is unilateral, but bilateral disease has been described. It is important to note that severe unilateral distention can give the appearance of bilateral involvement.

The diagnosis of excess air in the guttural pouch can be made clinically, by endoscopy, or by radiography. Endoscopy often shows severe pharyngeal collapse (see Fig. 11). On lateral radiographs, the distention can extend beyond the second cervical vertebra (see Fig. 13). In early cases, manual compression of the pouches can relieve the distention, confirming the presence of air. To confirm that air is distending the pouch, a catheter can be placed in the affected side to allow decompression. Alternatively, needle puncture can be performed through Viborg’s triangle, taking care to use aseptic
technique. A temporary tracheostomy may be required in the presence of severe respiratory distress.

Before surgically attempting treatment of guttural pouch tympany, a complete physical examination should be performed to identify other

Fig. 11. Endoscopy of a foal with guttural pouch tympany showing severe collapse of the dorsal pharyngeal wall.

Fig. 12. Illustration of a foal with guttural pouch tympany. Note the severe distention in the region of Viborg’s triangle.
problems, such as upper or lower airway infection, and in the young foal to ensure adequate transfer of passive immunity.

Treatment of tympany is aimed at restoring normal function of the pharyngeal opening. If edema associated with an upper airway obstruction is suspected, long-term catheterization and treatment of the upper airway condition can achieve that goal.

Most commonly, surgical intervention is required. The techniques described include fenestration of the septum between the guttural pouch, with or without enlargement of the ipsilateral pharyngeal opening or resection of the mucosal fold [18]. Creation of a fistula with the pharynx has also been described as an alternative method of achieving drainage. Fenestration is performed through a Viborg’s triangle approach. The median septum is grasped, and an opening of 2 to 3 cm in diameter is created. Alternatively, an endoscope is placed in the normal side, and the septum resection is performed under endoscopic guidance (Fig. 14). Because the septum bulges into the nonaffected side, it makes grasping the mucosa easier. It is important to create an opening of at least 2 cm in diameter, or closure can result in recurrence of the condition. A transendoscopic laser fenestration technique has also been described [19]. Care must be taken not to damage the nerves that are in proximity to the septum. Fenestration alone is successful if the problem is unilateral. If bilateral involvement is identified, however, enlargement of the pharyngeal openings must also be done. This can be performed by grasping and resecting the mucosal fold or,
more simply, by inserting forceps in the opening and manually enlarging it. In a recent report, a combination of the two techniques was recommended for better results [18].

Surgical treatment of guttural pouch tympany carries a good prognosis provided that care is taken to avoid iatrogenic neurologic damage. The most common surgical complication is recurrence of the tympany after closure of the fenestration or because of an abnormal pharyngeal opening. Reintervention is needed to correct these problems [18].

**Mycosis**

Guttural pouch mycosis is an infrequent disease of the upper respiratory system, but approximately half of the horses with guttural pouch mycosis with epistaxis die of fatal hemorrhage if untreated [20,21]. The etiology of the disease is not well understood, although it has been postulated that the fungal infection (*Aspergillus* spp) may occur secondary to an aneurysmal dilatation of the affected artery (Fig. 15) [22–24]. Alternatively, the aneurysm may be secondary to weakening of the vessel wall. No apparent age, sex, or geographic predilection has been demonstrated. The disease usually involves only one guttural pouch; however, as the disease progresses, it may
erode through the median septum and may even extend into the opposite guttural pouch.

The clinical manifestations of guttural pouch mycosis result from the involvement of the blood vessels and nerves underlying the mycotic infection and the degree of mucosal erosion. The size of the fungal lesion, however, does not necessarily relate to the severity of the disease. Horses may be presented with a mucoid nasal discharge from one nostril, an acute or multiple episodes of epistaxis, moderate to severe guttural pouch hemorrhage, or neurologic dysfunction. Usually, several bouts of epistaxis occur before a fatal episode, but there is no predictable pattern. The fungal plaques are usually found at one of the two characteristic sites: most are on the roof of the medial compartment, but others are on the lateral wall of the lateral compartment [25,26]. Mycotic ulcerations most frequently involve the ICA and, less commonly, the ECA or MA. When pharyngeal branches of the glossopharyngeal or vagus nerve are involved, nasopharyngeal dysfunction and dysphagia may be present. Damage to the recurrent laryngeal nerve can produce unilateral laryngeal hemiplegia, and Horner’s syndrome can develop if sympathetic nerve fibers are involved. Extension of the infection to adjacent structures is rare but has been reported, including pharyngeal fistula, erosion of the septum, weakening of the tendon of insertion of the rectus capitis ventralis muscle, middle ear infection, osteitis of the underlying bones, and atlanto-occipital joint infection [27]. These sequelae are serious and often necessitate euthanasia.

Fig. 15. Angiography of the internal carotid artery in a horse with guttural pouch mycosis showing aneurysmal dilation of the vessel (arrow).
Diagnosis

The diagnosis is made with endoscopy. Mucus and blood can be seen draining from the guttural pouch opening(s) (Fig. 16). If there is active bleeding, visibility may be poor because of the presence of a hematoma and accurate location of the lesion may not be possible. The fungal lesion usually takes the appearance of a plaque-like diphtheritic membrane or mass (Fig. 17). If the lesion cannot be localized to the ICA in the caudal medial aspect of the pouch, the ECA or MA may be involved (Figs. 18 and 19). Care should be taken during the introduction of the endoscope into the guttural pouch and during the examination not to dislodge or disturb the blood clot that has formed. Also, the fungal plaque should be left undisturbed so as to minimize the possibility of further hemorrhage before treatment is initiated. The contralateral pouch should be examined for possible extension of the lesion and for possible concurrent bilateral mycosis. In some horses with an extensive lesion, the medial septum may be destroyed, resulting in a fenestration and communication of the affected guttural pouch with the opposite guttural pouch or a fistula with the pharynx (Figs. 20A, B). Pharyngeal and laryngeal function should be assessed during the endoscopic examination. There may be ipsilateral laryngeal paresis on the affected side, and there may be evidence of nasopharyngeal paralysis, dorsal displacement of the soft palate, and food material in the nasopharynx as a result of dysphagia.

Fig. 16. Endoscopy of the pharynx of a horse with guttural pouch mycosis showing laryngeal hemiplegia and blood originating from the affected pouch.
The major differential diagnosis for acute and profuse bleeding of guttural pouch origin is avulsion of the longus capitis muscle(s) from the insertion of the basisphenoid bone after trauma [28]. This can produce acute and profuse epistaxis as a result of hemorrhage into the guttural pouch (see section on longus/rectus capitis rupture). This condition is differentiated from guttural pouch mycosis on the basis of a history of recent trauma, painful swelling in the area of the parotid and Viborg’s triangle, radiographic findings, and endoscopic appearance. Other reported causes of bleeding from the guttural pouch include neoplasia and foreign bodies [29,30].

Treatment

Once the diagnosis is confirmed, medical or surgical treatment should be initiated immediately. If left untreated, it is likely that the lesion will grow and become more invasive, and the risk of fatal hemorrhage is high.

Medical treatment. Response to local and parenteral treatment is slow and equivocal, probably because of lack of knowledge of the pathogenesis of the disease [20]. If the owner refuses surgery, the fungal lesion has not caused bleeding, and there is no apparent imminent risk of bleeding (the lesion does not seem to be localized over a large artery), medical treatment is initiated. It may take months (depending on the size of the fungal plaque) to resolve the lesion by medical treatment. This is in contrast to the situation in horses that have surgical occlusion (balloon catheter technique or transarterial coil
occlusion) of the affected arteries, with the fungal lesions resolving spontaneously without further treatment [24]. Nonirritating antifungal solutions can be applied topically through an indwelling catheter placed through the guttural pouch opening or directly sprayed on the lesion through the endoscope on a daily basis [31]. The dorsal location of the lesions, often covered by a diphtheric membrane and necrotic debris, makes such treatment difficult, however. Systemic antifungal agents have also been used to resolve mycotic lesions; however, the treatment is usually expensive, may be nephrotoxic, and may cause phlebitis [20]. During the treatment, there is always a risk of bleeding.

Surgical treatment. To prevent all hemorrhage from the guttural pouch, forward (normograde) and retrograde flow should be prevented from all affected vessels, because neither the ICA nor the MA is an end artery [24,32,33]. Many surgical options have been described, but only two of them (options 3 and 5) are commonly used to achieve this goal.

1. Ligation of the CCA on the affected side with the horse standing or under anesthesia is considered an emergency procedure [34]. It can prevent hemorrhage from the ICA, but it does not prevent retrograde flow through collateral vessels or from the cerebral arterial circle (circle
of Willis) [10]. Recently, various methods of emergency hemorrhage control have been examined [35]. In that study, ipsilateral CCA occlusion was associated with an increased retrograde flow in the ICA. For acute control of ICA hemorrhage, bilateral CCA occlusion or ipsilateral ICA occlusion was recommended. To reduce ECA flow, occlusion of either one or both CCAs, the ipsilateral CCA rostral to the ICA bifurcation, the ECA, the major palatine and ECA arteries, or the major palatine and CCA was recommended [35].

2. A double ligation of the ICA proximal (cardiac side) and distal (cranial side) to the lesion of the guttural pouch has been described. Because of the degree of difficulty, a high complication rate (including fatal hemorrhage), and the development of more successful techniques, this approach to treatment has been abandoned.

3. Because of concerns about the continued risk of hemorrhage from retrograde flow from the cerebral arterial circle (circle of Willis) and because double ligation is not always possible, a balloon-tipped catheter technique was developed for intravascular occlusion of the affected ICA [32,33]. Balloon occlusion of the affected artery(ies) is effective in preventing fatal hemorrhage provided that the catheters are accurately
placed and there is no aberrant vascular anatomy. Placement of the ICA balloon catheter is technically easy compared with placing catheters into the ECA and MA, where experience and skill are necessary [36]. A secure thrombus forms within the affected arteries within days of occlusion. Intraoperative hemorrhage can occur if the catheter

Fig. 20. (A) Endoscopy of the guttural pouch of a horse showing a fungal plaque on the median septum (arrow) with erosion of the median septum (arrowhead). (B) Same horse showing a fistula in the pharyngeal recess (arrow).
passes accidentally through the weakened wall of the artery at the site of the lesion or if the anatomy of the ICA is abnormal [37,38]. If ICA balloon occlusion does not stop the hemorrhage, it can be assumed that the continued hemorrhage is from the ECA or MA. A combination of ICA balloon occlusion and ligation of the ECA and palatine arteries can be performed in an active bleeding horse. A serious complication associated with the combination of ICA balloon-tipped catheterization and ECA and major palatine artery ligation is blindness on the affected side as a result of ischemic optic neuropathy [39,40]. Occlusion of the ECA and MA can also be performed using balloon-tipped catheterization. This technique requires a second and third approach, respectively. A 6-French venous thrombectomy catheter is inserted into the transverse facial artery and advanced in a retrograde direction through the superficial temporal artery for 12 cm so as to place the balloon tip within the ECA; the balloon is probably against the origin of the superficial temporal artery. The MA is occluded via an arteriotomy of the major palatine artery through the oral cavity. A 6-French venous thrombectomy catheter is advanced distally for a distance of 40 to 44 cm in a 450-kg horse. The balloon is inflated, and the catheter is at this point against the wall of the MA, where it enters the caudal alar foramen. With all balloon-tipped catheter techniques, the redundant portion of the catheter is secured to the skin and the skin incision is closed in routine fashion. The catheter can usually be left in place after ICA occlusion, but must be removed from the transverse facial and major palatine sites. A period of 7 to 10 days is recommended after surgery before catheter removal. Incisional drainage, breakage of the catheter during removal, retrograde infection, recurrent epistaxis, and inappropriate catheter placement have been described as complications [20].

4. Cheramie et al [41] described occlusion of the ICA artery with a detachable balloon catheter system. The balloon delivery system (Yocan Medical Systems, Thornhill, Ontario, Canada) is introduced into the ICA and advanced approximately 13 cm or until resistance is met. This distance corresponds with the proximal bend or between the proximal and distal bends of the sigmoid flexure of the ICA, which is a safe distance from the cerebral arterial circle [33]. Alternatively, the catheter is advanced under fluoroscopic guidance. Once positioned appropriately, the balloon is inflated and released and the carrier and guiding catheters are withdrawn. The detachable balloons immediately occlude the vessel, and a thrombus then forms in the occluded vessel [41].

5. Recently, the transarterial coil embolization technique has been favored over the balloon-tipped catheter technique and is considered to be the treatment of choice [24,42,43]. The coil embolization technique combines angiographic studies to visualize any unusual vessels and sites of bleeding with selective embolization/occlusion of the affected
vessels. Failure to identify and occlude aberrant branches may result in fatal hemorrhage and cerebral lesions [22,26]. Compared with the balloon catheter technique, transarterial coil embolization allows visualization of the vessels involved throughout the procedure because it is performed under fluoroscopic guidance. It can be performed during active bleeding, and there are no catheters embedded within the subcutaneous tissues at the end of the procedure. It is less invasive and associated with a shorter period of anesthesia and hospitalization.

Under general anesthesia, the horse is placed in lateral recumbency, with the affected side uppermost, and the proximal aspect of the jugular groove is clipped and prepared aseptically. A single surgical approach is sufficient to allow access to all vessels (ICA, ECA, MA, and small branches) under fluoroscopic guidance. An 8-cm skin incision is made at the junction of the proximal and middle third of the neck just above the jugular vein. The carotid trunk is isolated and then punctured with an angiographic needle, and a 6-French introducer system is placed in the artery in a distoproximal direction. A 6-French single end-hole nylon angiographic catheter is advanced rostrally into the CCA (important) to the level of the ICA under fluoroscopic guidance. There are variations in the origin of the ICA: in some horses, it rises directly from the CCA either proximal or distal to the origin of the occipital artery, but it occasionally rises from a common trunk with the occipital artery (Fig. 21).

An angiogram is performed by hand injection of 10 to 20 mL of iohexol/heparinized saline (1:2 ratio) to identify the ICA, ECA, and occipital artery. Injection of contrast material is repeated to evaluate for the presence of any aberrant vessels and to estimate the diameter of the ICA. The diameter of the artery is estimated and corrected for

![Angiographic image showing the internal carotid and occipital arteries arising from a common trunk (arrow). Rostral is to the left.](image-url)
magnification by comparing it to the 3 mm diameter catheter. The ICA is the first artery embolized at the level of its superimposition to the basisphenoid bone and caudal to the sigmoid flexure (Fig. 22). Occlusion of this site first will protect the brain from accidental air or thrombus embolization. The distal ICA is embolized midway between the first embolization and its origin from the CCA. Pre-embolization angiography is mandatory before embolization for anatomic identification and location of the vessels, exclusion of vascular anomalies, and correct positioning of the embolization coils [32,41,43]. In the author’s experience, small or aberrant arterial branches are often identified as the primary site of bleeding and could be selectively embolized [44]. Maintaining the catheter in place, a Dacron fiber-covered, stainless steel, occluding spring embolization coil (Cook Diagnostic and Interventional Products; Cook Medical, Bloomington, IN) of the proper diameter is introduced through the catheter and placed within the ICA using a guidewire. A coil slightly larger than the artery is chosen. Additional smaller imbricating embolization coils are introduced until complete occlusion is obtained. The catheter is withdrawn into the caudal ICA, and the same procedure is repeated. The catheter is withdrawn into the CCA and advanced to repeat the same procedure in the caudal MA and

![Fig. 22. Angiography showing correct placement of coils in the internal carotid artery. Complete occlusion is demonstrated by the failure to image contrast material past the coils (arrow). Rostral is to the left.](image-url)
rostral ECA. The MA is embolized distal to the superficial temporal artery and proximal to the infraorbital, buccal, and mandibular alveolar arteries (Fig. 23). The ECA is embolized caudal to the origin of the caudal auricular artery (Fig. 24). The ECA requires the largest size and number of coils to achieve immediate and complete occlusion. Throughout the procedure, extreme care is taken to avoid injection of debris, air bubbles, or thrombus within the catheter.

After coil placement, the catheter and introducer system are removed. The CCA puncture site is closed using 5-0 silk in a cruciate pattern, and the muscle layers and skin are closed in a routine fashion.

The prognosis after treatment for guttural pouch mycosis depends on the degree of cranial nerve involvement. Medical therapy with topical antifungal treatment requires prolonged treatment and places the horse at risk of hemorrhage. It is now recognized that with successful occlusion of all involved vessels, fungal plaques resolve without further treatment in 30 to 60 days. Balloon-tipped catheterization without angiography is successful provided that the vascular anatomy is normal. In the authors’ experience, abnormal vascularization or neovascularization is common with this disease such that preocclusion angiography is definitely optimal. The ability to occlude affected vessels selectively with a minimally invasive approach makes transarterial coil embolization the preferred treatment. This requires

Fig. 23. Angiography of the maxillary artery (arrowhead) showing the location of the superficial temporal artery (arrow). Rostral is to the left.
the use of a fluoroscopy unit, however, which may not be available. Horses with grade III laryngeal hemiplegia may improve, but horses with grade IV hemiplegia may require a laryngoplasty. Horses that are dysphagic usually recover, but recovery can take months. When neurologic deficits are present, treatment should be initiated as soon as possible to increase the likelihood of return to function.

**Longus capitis/rectus capitis rupture**

Rupture of the longus or rectus capitis muscle is included in the discussion of guttural pouch disease because this condition results in severe epistaxis of guttural pouch origin as well as blood and blood clots within the guttural pouch. The major differential for this condition is guttural pouch mycosis.

The longus capitis is the largest of the three flexors of the head, which also include the rectus capitis ventralis and the rectus capitis lateralis. The longus capitis is located along with and dorsal to the two recti within the septum separating the two guttural pouches. The rectus capitis muscles insert on the occipital bone, whereas the longus capitis inserts on the basisphenoid bone.

The cause of the condition is traumatic. Historically, falling over backward is the most common related event.
Epistaxis, often severe, is present on initial examination. The neurologic examination can be normal, or involvement of cranial nerves VII and VIII may be identified by the presence of ear, eyelid, and lip droop; head tilt; nystagmus; and ataxia. Cranial nerve involvement resembles that observed with stylohyoid arthropathy. On endoscopy, there is pharyngeal collapse and blood is seen exiting the guttural pouch. Within the guttural pouch, a submucosal hematoma within the median septum collapsing the medial compartment as well as blood clots within the pouch can be seen (Fig. 25). The ICA, ECA, and MA are not involved, although this can be difficult to determine initially because of the extensive blood clots. The submucosal hematoma is seen on endoscopy of either pouch, although it is usually more visible on one side. Radiographs reveal soft tissue opacification of the guttural pouch with narrowing of the pharynx caused by collapse of the dorsal pharyngeal wall. Bone fragments can sometimes be present ventral to the basisphenoid bone, indicating an avulsion fracture (Fig. 26) [28,45].

Treatment is supportive and aimed at minimizing inflammation, treating blood loss with fluids or transfusion as deemed necessary, and rest until resolution of signs. Resolution of the hematoma is usually uneventful, although antibiotic coverage is indicated to prevent abscess formation. If neurologic deficits are present, complete resolution may not occur and mild

Fig. 25. Endoscopy of the right guttural pouch of a horse with longus capitis rupture. Note the submucosal hemorrhage on the median septum (arrow).
deficits may persist. In one case series, recurrence of trauma resulted in fatal epistaxis [28].

Stylohyoid arthropathy

Stylohyoid arthropathy in the horse is thought to be a sequela to otitis media. Because the disease has never been reproduced, the proposed pathogenesis described here is speculative. It is thought that a low-grade bacterial infection affects the mucosal lining of the tympanic bulla. This infection may be hematogenous or may be from otitis externa or guttural pouch infection. The condition progresses to involve adjacent structures, such as the proximal stylohyoid bone and temporohyoid bone. This bony proliferation and resulting degenerative joint disease lead to eventual fusion of the temporohyoid joint. Once ankylosis of the joint occurs, clinical signs may temporarily improve. With transfer of forces across the hyoid apparatus from tongue movement, however, an acute fracture across the petrous temporal bone may result. The fracture line most commonly occurs between the petrous temporal bone and the tympanic bulla, extending into the internal acoustic
meatus. Alternatively, infection may spread through the internal acoustic meatus, causing meningitis or encephalitis. The close arrangement of the facial, vestibulocochlear, vagus, and glossopharyngeal nerves with these bony structures results in the common clinical manifestations of the disease. In the horse, *Actinobacillus equuli* is the most common isolate [46,47].

In the early stages, head tossing, ear rubbing, resentment of the bit or bridle, pain over the base of the ear, or dropping of feed when eating is seen. Because of the close proximity of the facial and vestibulocochlear nerves, head tilt, nystagmus, weak extensor tone, and facial nerve paralysis (eg, ipsilateral ear drop, muzzle deviation, inability to close the eyelids, collection of food in the buccal cavity) are seen with progression of the disease (Fig. 27). If

![Fig. 27. Illustration of a horse with stylohyoid arthropathy showing head tilt and facial nerve paralysis.](image)
a pathologic fracture occurs, there is acute deterioration of the clinical condition with ataxia, seizures, or recumbency. The parasympathetic efferent innervation to the eye that supplies the lacrimal gland also courses with the facial nerve such that keratoconjunctivitis sicca and myosis may be observed. Laryngeal hemiplegia and megaesophagus have been described. Rarely, frank purulent discharge from the external ear has been described. Clinical signs are most often unilateral, although bilateral involvement has been observed. Even when endoscopy or radiography suggests bilateral disease, signs are usually lateralized to one side. The differential diagnosis of stylohyoid arthropathy includes skull fracture, guttural pouch mycosis, encephalitis, equine protozoal myelitis, and neoplasia.

Diagnosis of stylohyoid osteoarthropathy is based on a complete physical and neurologic examination, endoscopy, and skull radiographs. The most specific diagnostic method is endoscopy of the guttural pouches [48]. On endoscopy, the stylohyoid bone appears enlarged at its junction with the temporal bone (Fig. 28). Radiographs can help to identify abnormalities of the stylohyoid bone, petrous temporal bone, and tympanic bulla. Occasionally, a fracture may be demonstrated (Fig. 29). With the advent of computed tomography and magnetic resonance imaging, a better understanding of the disease should be gained.

Fig. 28. Endoscopy of the guttural pouch of a horse with stylohyoid arthropathy. Note the markedly enlarged caudal aspect of the stylohyoid bone (arrow).
Options for treatment include medical management with or without surgery. Medical management is an important component of treatment, because most horses have corneal ulceration. Because of the proposed infectious basis of the disease, long-term systemic antibiotic therapy is recommended. Based on previously reported results of cultures obtained from these cases, trimethoprim sulfa is recommended. Surgical treatment is aimed at prevention of petrous temporal bone fracture by preventing the transfer of forces from the tongue to the hyoid apparatus. The procedure, stylohyoid ostectomy, was first described in 1994, but there is limited information on its efficacy and long-term outcome [49]. The horse is placed in dorsal recumbency, and an approach is made medial to the ramus of the mandible on the affected side. The first hyoid structure encountered is the ceratohyoid, and the stylohyoid lies deep to it. The periosteum is carefully elevated from the stylohyoid, and rongeurs or wire is used to remove a section of the hyoid bone (Fig. 30). The ends of the bone should be smoothed off with a rasp to avoid laceration of surrounding vascular

Fig. 29. Dorsoventral radiographic projection of the skull of a horse with stylohyoid arthropathy showing enlargement of the proximal aspect of the stylohyoid bone (arrow).
structures, particularly the lingual artery. Reported complications of the procedure include hemorrhage and temporary dysphagia from hypoglossal nerve damage.

In general, the prognosis for stylohyoid arthropathy is guarded and is based on the severity of the clinical signs. Often, some degree of facial nerve paresis persists. The corneal ulcers are difficult to treat, because there is an underlying problem with lid closure and tear production. A temporary tarsorrhaphy may help to manage the ocular complications until facial nerve function returns. Severe corneal ulceration may require enucleation. Horses with vestibulocochlear nerve involvement may learn to compensate visually, but signs may worsen when the horse is blindfolded.

References


Fig. 30. Lateral projection of the skull of a horse after stylohyoid ostectomy (accolade).


