Esophageal Strictures and Diverticula

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ABSTRACT: Esophageal luminal strictures commonly occur after trauma to the esophagus that results in damage to any of the esophageal layers. Healing occurs predominantly by contraction fibrosis, resulting in stricture formation, subsequent reduction in luminal diameter, and, eventually, repeated episodes of esophageal obstruction. Diagnosis of a stricture routinely involves a physical examination, plain and contrast radiography, and endoscopic examination. Depending on the layer(s) affected, the stricture type is classified and has a bearing on surgical management techniques. Initially, medical management should be attempted and spontaneous healing of mucosal defects allowed; however, once a stricture has developed, surgical intervention may be necessary if it has not resolved in 60 days. Surgical intervention can involve esophagomyotomy with or without esophagopexy, partial esophageal resection, esophagoplasty, and muscular patch grafting or mucosal fenestration. Postoperative complications (e.g., leakage, infection, respiratory effects) are more likely if the esophageal lumen has been entered. One study reported successful surgical resolution of strictures in 44% of horses.

Luminal esophageal obstruction is the most commonly diagnosed esophageal disorder in horses and is often caused by impaction with feed or bedding material.[1–3] Although resolution of esophageal impaction is most often achieved conservatively, internal esophageal trauma can cause considerable damage and ulceration of the mucosa.[2] Spontaneous healing of mucosal defects with conservative management consisting of administration of antibiotics and NSAIDs as well as feeding of soft feed has been reported.[1,4] However, because the healing process is thought to occur mainly by contraction fibrosis,[5] stricture formation and significant reduction of the esophageal lumen may result, predisposing the horse to recurrent episodes of obstruction. Esophageal strictures can also be congenital or may occur after external neck trauma, as a sequela of previous esophageal surgery, or after esophageal rupture.[1,2]

Based on the involvement of the different layers of the esophageal wall and the resultant

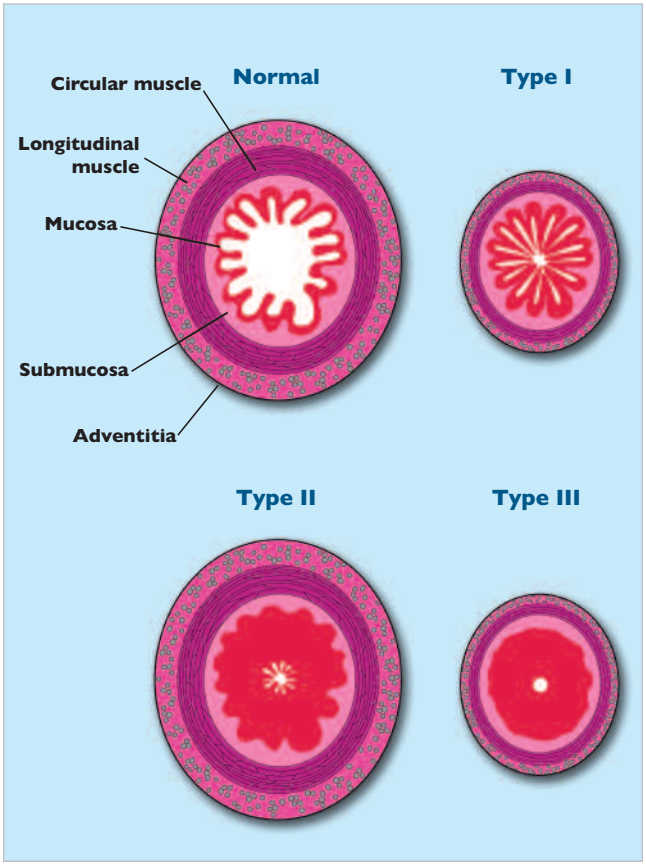


Figure 1. Cross section of the esophagus: normal, type I stricture (muscular layers involved), type II stricture (mucosal layers involved), and type III stricture (all layers involved).

location of fibrosis, esophageal strictures are categorized as follows[1] (Figure 1):

- **Type I**—Lesions involving the adventitia and tunica muscularis
- **Type II**—Lesions involving only the mucosa and submucosa
- **Type III**—Strictures involving all layers of the esophageal wall

Determination of the type of esophageal stricture is important because, to a certain extent, it dictates the type of surgical treatment and the prognosis.[2] The proportion of the luminal circumference involved in the stricture is also an important prognostic factor because horses with mural strictures involving only a sector of the luminal circumference appear to have a more favorable prognosis with surgical treatment than horses with annular lesions that involve the entire circumference.[3]

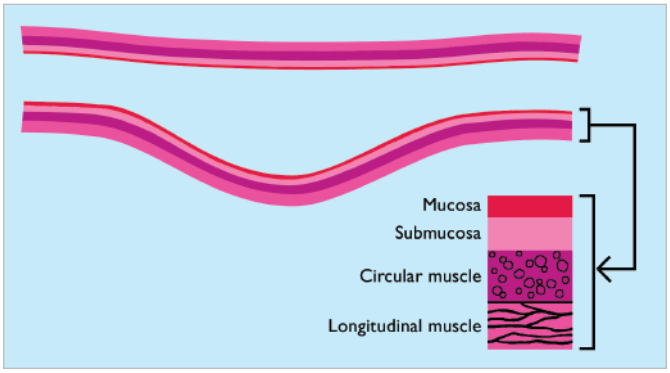
A diverticulum is a pocket- or balloon-like projection from the wall of a tubular structure. Esophageal diverticula in horses are acquired and represent local extensions of the esophageal lumen. Two types of diverticula can be differentiated. **Traction (true) diverticula** result from external traction on the esophageal wall due to periesophageal scarring (Figure 2). Periesophageal fibrosis may occur during healing of wounds external to the neck or after previous esophageal surgery, such as esophagostomy.[1] Contraction associated with healing after esophageal perforation may also result in formation of a traction diverticulum.[1] Traction diverticula are usually clinically asymptomatic and may represent incidental findings on contrast radiographs or during endoscopic examination.[1,2] **Pulsion (false) diverticula** are caused by protrusion of esophageal mucosa and submucosa through a defect in the esophageal musculature (Figure 2). It has been hypothesized that damage to the muscle layers of the esophagus occurs because of external trauma[2,6] or pressure fluctuations in the esophagus, resulting in damage to the esophageal muscle fibers.[1] High fluctuations in esophageal pressure can also occur as a result of obstruction of the esophagus with feed material[1] or the use of excessive pressure to resolve a feed obstruction. However, external trauma to the cervical area can also result in formation of pulsion diverticula.[7,8] Pulsion diverticula most often require surgical treatment because they progressively enlarge, which, in turn, can result in recurrent esophageal obstruction due to extraluminal compression or in rupture and subsequent periesophageal inflammation and infection.[1]

DIAGNOSIS

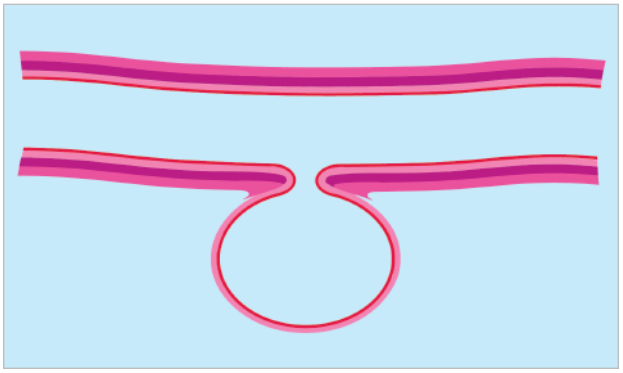
Physical Examination

Horses with esophageal strictures usually present with a history of one or multiple episodes of esophageal obstruction. Alternatively, external trauma to the neck (e.g., a kick by another horse), previous esophageal surgery (e.g., esophagostomy), or esophageal rupture may have occurred. If obstruction is caused by an esophageal diverticulum, progressive swelling over the ventrolateral cervical area may be observed. Obstructive esophageal disease is manifested by distress; ptyalism; dysphagia; anorexia; repeated extension of the neck; coughing; and regurgitation of feed, water, and saliva from the mouth and nostrils.[1,2] Odynophagia (painful swallowing) may be observed after resolution of esophageal obstruction. The laryngeal and cervical area should be thoroughly pal-

Figure 2. Types of diverticula.



Traction diverticulum.



Pulsion diverticulum.

pated. Distention cranial to an esophageal obstruction may be visible or palpable,[2] or if there is no obstruction at the time of presentation, previous esophageal trauma may be evidenced by local scarring or a depression in the contour of the ventral neck originating from fibrous constriction.[1] Crepitus or cellulitis over the area may indicate the loss of esophageal integrity and necessitates thorough esophagoscopic and/or radiographic evaluation. A complete oral examination should always be performed because ptyalism, dysphagia, and anorexia are also consistent with oropharyngeal disease (e.g., dental disease, oral neoplasia), a foreign body, or a cleft palate.[1] Careful passage of a nasogastric tube may confirm ongoing obstructive disease or a significant decrease in luminal diameter and may aid in identifying the site of involvement. Prolonged esophageal disease and recurrent episodes of obstruction associated with dysphagia are likely to result in secondary aspiration pneumonia. Therefore, a thorough workup of the lower respiratory tract, including thoracic auscultation, culture and cytology of a transtracheal lavage sample, and diagnostic imaging (e.g., thoracic radiography and ultrasonography), is indicated. Particular attention should be paid to this matter when planning esophageal surgery using general anesthesia.

Esophagoscopy

Esophagoscopy is a safe and rapid method to evaluate mucosal disease and changes in luminal size in standing horses and should be a component of the complete assessment of esophageal disease.[1] A flexible fiber endoscope that is 2 to 3 m long allows evaluation of the entire length of the esophagus. Sedation of the horse for the examination using α_2-agonists (e.g., xylazine hydrochloride, detomidine hydrochloride) results in decreased esophageal motility[2,9] and increased safety for the patient and handlers. The risk of damage to expensive endoscopic equipment can be further minimized by passing a shortened nasogastric tube into the cranial esophagus and then passing the endoscope through the lumen of the tube.

If possible, the endoscope should first be passed through the cardia, and the entire esophagus should be visualized in a caudal to cranial direction by slowly withdrawing the scope under continuous insufflation and irrigation, if necessary.[1,2] However, substantial reduction of the luminal diameter due to an intraluminal obstruction, a stricture, or a diverticulum at the time of examination may prevent the examiner from passing the fiber endoscope into the stomach. Suspicious segments of the esophagus should be examined several times by repeated passes over the area. The mucosa at the level of the cranial esophageal sphincter may be difficult to evaluate due to repeated stimulation of the swallow reflex.[1,2] When the endoscope is withdrawn in a caudal to cranial direction, normal longitudinal folding appears in the esophageal mucosa. Transverse folds can be produced by advancing the endoscope toward the stomach, which may give a false appearance of a stricture. Normal swallowing causes temporary obstruction of the view through the endoscope and results in changes in the luminal diameter that could falsely be interpreted as stenotic rings or diverticula.[1] True lesions can be differentiated from these artifacts based on their persistence through several swallowing episodes. Immediately after resolution of an obstructive episode, full-thickness mucosal ulceration of a sector or the entire circumference of the esophagus may be detected (Figure 3). These areas should be

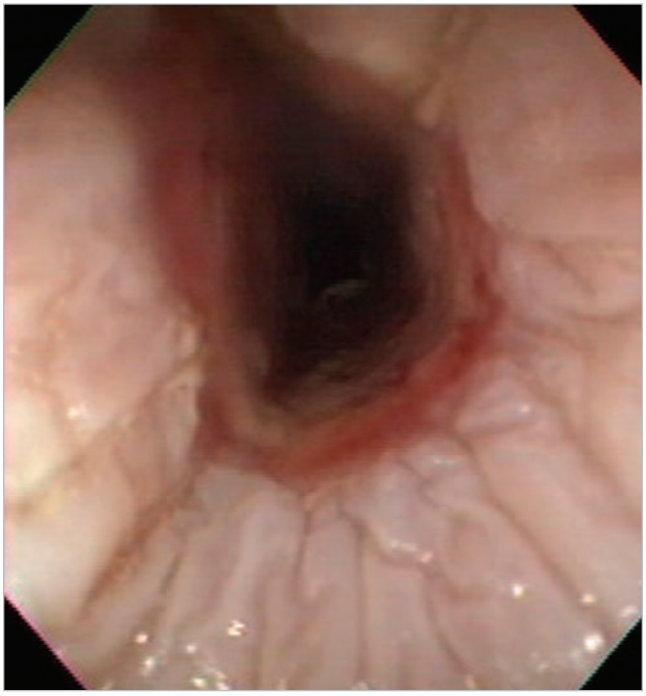


Figure 3. Complete circumferential esophageal ulceration.

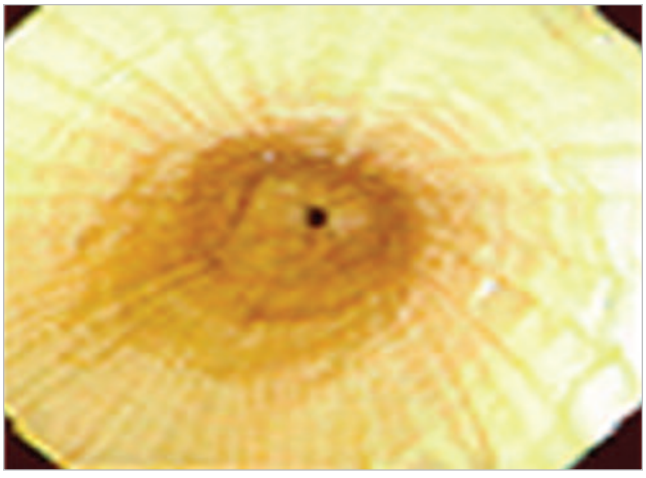


Figure 4. Endoscopic view of an esophageal stricture.

reevaluated by endoscopy after 2 months because they are very likely to result in stricture formation. After 60 days, the lumen at the stricture site is at maximal diameter and mucosal healing is complete.[4] During this time, treatment involving administration of broad-spectrum antibiotics and NSAIDs as well as feeding a soft, pasty, roughage-free diet is recommended to facilitate mucosal healing.[4]

During endoscopic examination, esophageal strictures appear as a persistent narrowing of the lumen (Figure 4). Traction diverticula appear as segmental dilations of the esophageal lumen. Differentiation from normal variation and fluctuation of the luminal diameter is based on the persistence of the dilation throughout several swallowing events. In pulsion diverticula, the opening of the diverticulum appears as a defect or hole in the esophageal mucosa rather than dilation.

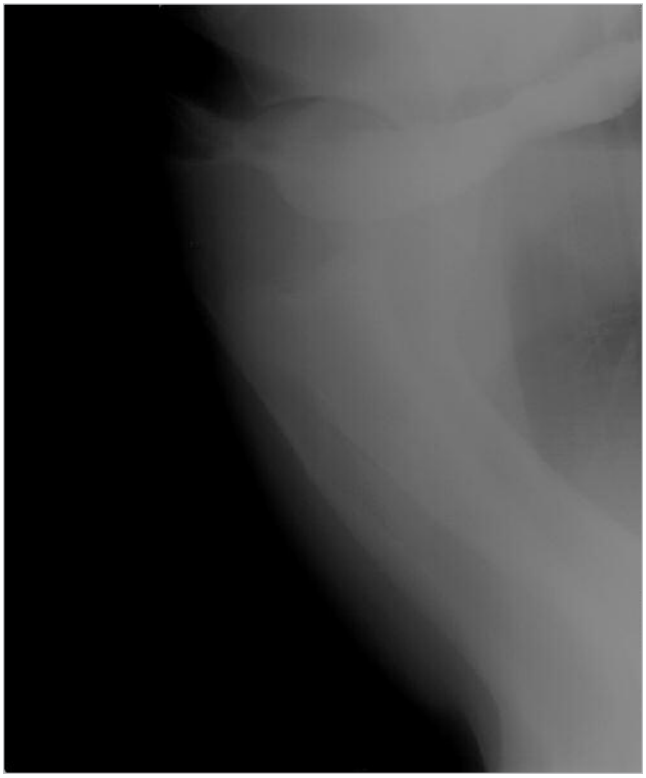


Figure 5. Esophagogram showing a traction diverticulum.

Because of an increased risk for perforation, esophagoscopy is contraindicated in cases of corrosive and necrotizing esophagitis after ingestion of caustic substances.[1]

Radiography

Radiographic evaluation of the esophagus is an important component of the diagnostic workup of esophageal disorders other than acute simple obstructions. However, radiographic evaluation of the thoracic part of the esophagus is often difficult due to the size of the equine thorax and the limited capability of radiographic equipment.[1] Esophagoscopy and esophageal contrast studies are necessary before surgery to precisely localize and determine the extent of conditions requiring surgical treatment.

Complete radiographic examination of the esophagus should be initiated with a survey film to establish radiographic technique.[1,2] The normal cervical esophagus is usually not visible on plain films. Several conditions, such as obvious radiopaque obstructions, perforation of the esophagus with gas lucencies in the surrounding soft tissue, or both, may be recognized on survey films and may not require contrast studies.[2] Negative-contrast radiography can be performed by air insufflation via a cuffed nasogastric tube. This may help visualize foreign bodies and identify diverticula or fistulas. Positive-contrast studies are conducted using barium sulfate in liquid or paste form or water-soluble iodinated solutions. Barium sulfate paste coats the esophageal mucosa for several minutes, making the timing of radiographic exposure less critical.[2] Sixty to 100 ml of contrast material is administered via a cuffed nasogastric tube[1,2] or by squirting it to the back of the mouth.[10] Caution is indicated when using the latter technique with iodinated solutions. Iodinated contrast materials are hypertonic and can cause severe pulmonary edema if they are accidentally aspirated.[2] If the horse can safely tolerate the procedure, sedation should be avoided for esophagography because it suppresses the swallowing reflex, possibly resulting in aspiration of contrast material.[2]

Figure 6. Double-contrast esophagogram showing an esophageal stricture.

Esophageal strictures and diverticula are best evaluated by obtaining a double-contrast distention esophagogram (Figures 5 and 6). A cuffed nasogastric tube is placed in the proximal esophagus, followed by injection of up to 500 ml of liquid barium sulfate suspension. After most of the barium sulfate solution has cleared, a

similar amount of air is injected under pressure into the esophagus, followed by immediate, airtight occlusion of the nasogastric tube. This technique provides optimal visualization of the esophageal mucosal surface.

SURGICAL TREATMENT OF ESOPHAGEAL STRICTURES

Without strict adherence to dietary alteration requirements, horses managed medically are prone to recurrence of acute complete obstruction and have poor long-term survival.[4] Conservative management of a stricture is aimed at dilation of the stenotic segment. Bougienage or pneumatic or hydrostatic dilators have minimal practical value in horses because of the limited availability of special equipment and chronicity of the problem. Chronic strictures usually have progressed too far, and the cicatrix is too firm to yield to dilation. For most veterinary surgeons, surgical management of esophageal strictures is reserved as a last option, and the potential pitfalls should be thoroughly discussed with the client. With the clinician mindful of this, surgical management of chronic esophageal strictures is considered superior to medical management.[3]

Surgical Anatomy

The esophagus of an adult horse is 125 to 150 cm long, depending on the animal's size. As the esophagus courses caudally, it deviates from dorsal to the trachea in the cranial third of the neck to the left side of the median plane in the middle third of the neck and lies ventral to the trachea at the thoracic inlet. The cervical part of the equine esophagus is the most accessible during surgery and constitutes more than 50% of the total length of the esophagus. The wall of the esophagus comprises four layers:

- **Tunica adventitia**—a fibrous layer
- **Tunica muscularis**—a muscular layer
- **Tela submucosa**—a submucosal layer
- **Tunica mucosa**—a mucous membrane

During surgical incision, the esophageal wall separates easily into two distinct sections. The elastic inner section, composed of the mucosa and submucosa, is freely movable within the relatively inelastic outer muscular layer and adventitia. The mucosa, which provides the greatest tensile strength after closure of an esophageal incision, is covered with stratified squamous epithelium and lies in longitudinal folds that obliterate the lumen, except during deglutition.

Esophagomyotomy and Esophagopexy

Strictures that are mural in origin (involving only the outer surgical section) respond to myotomy. For this surgery, the patient should be under general anesthesia,

A stricture can involve any or all of the esophageal layers: the mucosa, submucosa, muscular layers, and adventitia.

Esophageal surgery is technically demanding, and complications requiring further surgical intervention are common. Reported surgical techniques for correction of chronic strictures of the equine esophagus include esophagomyotomy, esophagopexy, partial or segmental esophageal resection, esophagoplasty, muscular patch grafting, and mucosal fenestration.[1,2,4,11–13] Muscle grafting and esophageal replacement techniques are usually used to treat leakage or when tissue deficits exist. Selection of surgical technique is generally based on the type of stricture.

and a nasogastric tube is passed to the level of the stricture to permit easy identification of the involved area. The esophagus is incised longitudinally to the level of the mucosa, through the stricture, and 1 cm distal and proximal to it. The nasogastric tube may be passed through the stenotic area at this point. From this incision, the muscularis is separated by sharp dissection from the mucosa around the entire circumference of the esophagus, or if esophagopexy is performed in conjunction with esophagomyotomy, the mucosa is dissected from the muscularis only 180° around the circumference of the stricture site.[14] When the mucosa is freed using these techniques, removal of a portion of the muscularis or multiple myotomy incisions are seldom necessary. Either the myotomy incision is not sutured or, if esophagopexy has been performed, the incised portions of the ipsilateral muscularis are sutured to the sternocephalic muscle ventrally and the periesophageal fascia dorsally.[14] This results in an increased circumference of the tunica muscularis and creation of a diverticulum.

Following esophagomyotomy, feeding small, frequent quantities of soft feed may be necessary if prestenotic dilation was present before surgery. When this dilation is no longer recognized on radiographs, normal feeding may be resumed. When esophagopexy is performed in conjunction with esophagomyotomy, it is recommended to restrict patient access to dry hay for a minimum of 60 days.[14]

Recurrence of postsurgical cicatricial stricture is slow to develop, with clinical signs occurring weeks or months after the operation. Conservative treatment (diet change to a complete pelleted ration) may be all that is necessary to resolve recurrent obstructions. A postsurgical stricture that occurs long after the original operation is usually due to mature nonresilient cicatrix and may not respond to dilation. If this postsurgical stricture is clinically debilitating, it is preferred to allow resolution of the acute inflammation before surgical revision. Surgical reintervention in a stenotic area of the esophagus before allowing acute inflammation from the previous surgery to subside greatly increases the propensity for restricture. If early intervention is necessary, a more hazardous procedure may have to be selected to correct the problem.

Partial Esophageal Resection

Longitudinal esophagomyotomy combined with mucosal resection can relieve strictures caused by esophageal rings or webs and annular stenosis of all muscle layers. Performed with the patient under general anesthesia, this procedure is indicated when the cicatrix involves the mucosa and prevents nasogastric passage. Following myotomy, a longitudinal incision long enough to permit identification of the diseased segment is made through the mucosa. Circumferential incisions are made at the proximal and distal edges of the mucosal cicatrix, which is removed, leaving the muscular tube intact for closure. When mucosal rings or webs are the cause of stenosis, the normal esophageal muscle should be apposed over the mucosal anastomosis, but in the case of annular stenosis that involves the entire esophageal wall, the muscularis should not be sutured. If possible, the horse should be fed through an esophagostomy tube placed through a separate incision distal to the stricture. When this is impossible, frequent feeding of small quantities of soft food may begin 48 hours after surgery and should be continued for a minimum of 10 days.

If the stricture is extensive and the mucosa cannot be sutured, regeneration within the muscle tube can readily occur. The muscularis may be sutured if it is healthy or

may be left open if only scar tissue remains. Spontaneous healing can be aided by esophagostomy tube feeding. When the stricture is located too close to the thoracic inlet to permit placement of a separate esophagostomy incision, the tube may be inserted directly through the stricture site. Recurrence of stricture following this procedure may be an indication for complete resection or patch grafting.

Complete Esophageal Resection

Esophageal resection and anastomosis have been recommended if the muscularis is damaged extensively and is useless as a scaffold for mucosal regeneration. Minimizing tension on the anastomosis is essential for a favorable result. Before surgery, it may be advantageous to train the horse to tolerate a standing martingale to prevent elevation of the head.[1]

A routine approach to the esophagus is used. A two-layer anastomosis is performed by closing the submucosa and mucosa in a simple continuous or interrupted pattern, followed by closure of the muscular layer in a simple interrupted pattern. The muscularis is the limiting layer of esophageal elasticity, and tension can be eased by making relief incisions adjacent to the anastomosis. After surgery, extraoral alimentation or feeding by esophagostomy is required. If extraoral alimentation is not used, a pelleted slurry should be fed, starting 48 hours after surgery. A diet of roughage should not be offered until evidence of esophageal healing has been confirmed by radiography or esophagoscopy.[1]

Esophagoplasty and Muscular Patch Grafting

Esophagoplasty may not be a viable surgical option for horses. A longitudinal incision in the esophagus with circumferential or transverse closure is of limited use in horses. It is only recommended for lesions less than 2 cm long because of excessive tension on the suture line with longer defects. Most lesions in horses are longer than 2 cm, and the abnormal tissue has poor suture-holding capacity.

No studies define the limits of esophageal resection in horses, but a 3-cm segment is the longest type mentioned in the literature.[15,16] If the size or nature of the lesion precludes resection and anastomosis, the use of a patch graft should be considered. The sternocephalicus[17] and brachiocephalicus[1] muscles appear to be the best for patch grafting.

Mucosal Fenestration

A final option for surgical repair of an esophageal stricture involves esophagostomy followed by fenestration of the mucosal and submucosal cicatrix. Extraoral alimentation of the patient is achieved through the esophagostomy, resulting in a traction diverticulum, thereby increasing the lumen size. In one report, several fenestrations were necessary and several longitudinal incisions of the fibrous mucosal cicatrix allowed complete resolution of the obstruction and return of the horse to a normal diet.[6]

Postoperative Complications

Postoperative complications associated with surgical procedures involving the esophagus include esophageal leakage, periesophageal infection, and subsequent surgical failure leading to repeat surgery. Postoperative resolution of the stricture and return to a normal diet occurred in 44% (four of nine) of the horses in one study.[3] Surgical repair of esophageal mural strictures was more successful than repair of annular or mucosal strictures.[3] Respiratory complications were aspiration pneumonia (72%) and pleuritis (18%).[3] Postoperative periesophageal infection occurred after nine of 17 (53%) surgical procedures.[3] Surgical procedures that entered the esophageal lumen had a significantly higher risk for infection and subsequent failure of the repair than procedures that did not enter the lumen (P = .01). Postoperative mortality was also significantly higher in the former than the latter (P = .04).[3] Esophageal fistulas occurred secondary to surgical intervention, perforation, and esophageal feeding-tube placement. Spontaneous healing of the fistula occurred in all long-term survivors. The presence of an esophageal fistula did not significantly influence survival.

Treatment of an esophageal stricture is often successful with surgical intervention.

ESOPHAGEAL DIVERTICULA: DIAGNOSIS AND TREATMENT

Esophageal diverticula are usually acquired and may lead to esophageal malfunction. Traction (true) diverticula are rarely symptomatic but may be identified as insignificant findings during endoscopy and contrast radiography.

Pulsion diverticula are more likely to be clinically significant. Diagnosis is usually made with the assistance of contrast radiography because the lesion can often be overlooked during endoscopy, depending on the size of the neck of the lesion observed from the lumen. Pulsion diverticula can be treated surgically using two methods[7,8]:

- In mucosal inversion, the mucosa is inverted back through the defect in the muscle, and the muscular layers are repaired. This minimizes the risk for infection and fistula formation because the mucosa is not incised.
- In diverticulectomy, the redundant mucosal–submucosal sac is removed, and primary closure of all the esophageal layers is used. Diverticulectomy should be used when the mucosal sac is very large and the neck of the diverticulum is very narrow. There is only a single report of the repair of an apparently congenital esophageal diverticulum using this technique.[18]

Mucosal inversion is preferred because it decreases the chance of postoperative leakage, infection, and fistulation and does not appear to predispose patients to postoperative obstruction.

After surgery, only soft foods should be fed for 4 to 6 days. The prognosis for surgical repair of a pulsion diverticulum is favorable unless the mucosal sac becomes so large that diverticulectomy is necessary. In one study, all horses survived long term after surgical treatment of esophageal diverticula.[3]

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1. Esophageal strictures are caused by
a. damage to the esophageal mucosa and subsequent constriction fibrosis.
b. feed impaction of the esophagus.
c. external neck trauma.
d. all of the above

2. Esophageal strictures are classified by the
a. duration of the lesion.
b. location along the esophagus.
c. diameter of the esophagus.
d. affected layers of the esophageal wall.

3. Important prognostic factors for patients with esophageal strictures include the
a. affected layers of the esophageal wall.
b. proportion of the luminal circumference.
c. duration of the lesion.
d. a and b

4. Esophageal diverticula are classified as
a. pulsion diverticula in which external traction on the periesophageal tissue causes a diverticulum.
b. traction diverticula in which lesions in the muscular layers of the esophageal wall result in protrusion of the esophageal mucosa.

c. local extensions of the esophageal lumen.
d. lesions that occur only when external esophageal trauma occurs.

5. Clinical signs of an esophageal stricture include
a. a single episode of esophageal obstruction.
b. frequent episodes of ptyalism, dysphagia, and odynophagia.
c. crepitus and cellulitis along the jugular groove.
d. Horner's syndrome.

6. Esophagoscopy is best performed by
a. passing an endoscope through the cardia of the stomach and then slowly withdrawing it to look for lesions.
b. distending the esophagus with air before advancing the endoscope to look for strictures.
c. observing suspicious segments several times by repeated passes over the area.
d. a and c

7. Radiographic examination of the esophagus should involve
a. a plain film study of the suspicious area.
b. a plain film study of the entire esophagus.
c. a contrast study alone.
d. a plain film study followed by a negative-contrast study, positive-contrast study, or double-contrast distention esophagogram.

8. Treatment of esophageal strictures involves
a. bougienage or dilators during the chronic stage.
b. increased frequency of feeding to aid natural bougienage.
c. only surgical relief of the stricture.
d. early conservative management of esophageal trauma, involving antiinflammatory therapy, followed by surgical relief, if necessary.

9. Esophagomyotomy suffices as surgical treatment of
a. strictures involving only the muscular layer.
b. strictures involving only the mucosa.
c. traction diverticula.
d. strictures involving all layers of the esophagus.

10. Mucosal inversion is preferred in treating a pulsion diverticulum because
a. it is technically easier.
b. it minimizes the likelihood of leakage and associated problems compared with mucosal resection.
c. it minimizes the likelihood of a traction diverticulum.
d. the alternative—diverticulectomy—results in stricture formation.