Equine emergency upper airway management

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Summary

Respiratory distress due to acute upper respiratory tract obstruction is an uncommon emergency in equine practice. However, clinicians should be confident with the approach to this truly life-threatening scenario. Clinical signs are obvious at rest and include increased respiratory effort, loud respiratory noise and recumbency as asphyxiation progresses. Many cases of upper respiratory tract obstruction involve the pharynx or larynx, though obstruction in other regions of the upper respiratory tract and other causes of respiratory distress should be considered. Generally, the obstruction can be bypassed by placing a nasotracheal tube under endoscopic guidance or by making a temporary tracheostomy to ensure a patent airway. Following this stabilisation, further investigation into the cause of airway obstruction can be performed. Endoscopy is usually the most valuable diagnostic tool, though other imaging modalities can be useful. Further empirical treatment is often required, though the specific management will vary depending on the pathology present.

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Introduction

Acute upper respiratory distress is an infrequently encountered emergency in equine practice (Mair and Lane 1996). However, it is important that practitioners are confident with the approach to this potentially life-threatening scenario, as prompt treatment is vital. This article will discuss some of the common causes of severe upper respiratory tract obstruction and the options for emergency management.

Clinical signs

Overt clinical signs of respiratory distress are typically present in cases of acute upper respiratory tract obstruction. They may include nasal flaring, reduced nasal airflow, an extended and low head position, and increased respiratory rate and effort (Dixon 1988). There is usually loud abnormal respiratory noise. In cases of upper respiratory tract obstruction cranial to the thoracic trachea, the degree of luminal reduction and respiratory noise is greatest during inspiration due to the negative transmural pressures in this phase of respiration (Rakesh et al. 2008). Severe cases may demonstrate cyanosis of the mucous membranes and affected horses are often distressed, and even recumbent as the degree of asphyxiation progresses (Abrahamsen et al. 1990). Examination may also demonstrate other localising signs such as lymphadenopathy, nasal discharge or evidence of trauma.

Differential diagnoses

There are many potential causes of acute respiratory distress, but the larynx and pharynx are the most common sites of obstruction. In some cases, clinical signs may readily implicate the affected region on initial physical examination, for instance in cases with obvious signs of trauma or facial swelling. This can be helpful in narrowing the list of differential diagnoses and may also be important for initial management (Mair and Lane 1990). It should be borne in mind that many cases presented with acute respiratory distress have actually had chronic disease for many weeks or months, which may have gone unnoticed by the owner but have now reached a ‘crisis’ point. Differential diagnoses for severe respiratory obstruction include:

Nasal Cavity

To cause severe respiratory distress, bilateral nasal cavity obstruction is typically present. Causes may include:

- Trauma– Severe bilateral trauma may result in fractures of the maxilla, nasal and frontal bones with significant soft tissue swelling and oedema, which can disrupt the nasal cavity resulting in obstruction (Mudge and Bramlage 2007).
- Severe nasal congestion or inflammation– Oedema and swelling of the nasal mucosa and submucosa typically occurs due to passive congestion and alterations in hydrostatic pressure within the nasal vasculature. This is most commonly observed during general anaesthesia where there is a low head position relative to the heart (especially in dorsal recumbency) and where anaesthetic agents may result in peripheral vasodilation (Lukasik et al. 1997, Clarke et al. 2014). It can also arise in conscious horses with a lowered head carriage, which can have a variety of causes such as central neurological disease or cervical pain. Severe bilateral jugular thrombophlebitis can restrict venous drainage and result in nasal congestion (Schwarzwald 2018). Generalised inflammation around the nose, such as following snake bites can also cause dyspnoea (Dickinson et al. 1996).
- Paranasal sinus disease (Fig. 1)– Space occupying lesions such as sinus cysts that involve the ventral and dorsal conchal sinuses can force the nasal septum toward the contralateral nasal cavity and result in bilateral nasal obstruction (Tremaine and Dixon 2001). Sinusitis can also result in secondary nasal mucosal oedema.
- Choanal atresia (Fig. 2)– The presence of a congenital membranous division between the nasal cavity and pharynx is occasionally encountered in equine neonates. Cases with bilateral choanal atresia will demonstrate severe respiratory distress immediately after foaling (James et al. 2006, Hawkins 2015).

- Neoplasia– Nasal cavity and paranasal sinus neoplasia can occasionally become sufficiently large to result in significant obstruction and respiratory distress (Head and Dixon 1999).

Pharynx

Respiratory distress arising from the pharynx may be a result of intraluminal obstruction or extraluminal compression:

- Trauma– Severe pharyngeal trauma is relatively infrequently encountered but can result in luminal obstruction and may involve foreign bodies (Sullivan and Parente 2003).
- Nasopharyngeal cicatrix syndrome– This syndrome is primarily reported in Texas, characterised by mucosal inflammation of the pharynx and larynx. Chronic cases often develop scarring which reduces the pharyngeal lumen (Norman et al. 2012).
- Pharyngeal foreign bodies– These are rare in horses but may occur by ingestion or in association with a penetrating wound (Kiper et al. 1992, Rush and Mair 2004).
- Intraluminal mass– Differential diagnoses may include a neoplastic lesion, granuloma or cyst (Sullivan and Parente 2003). These cases often initially present with other clinical signs, such as dysphagia, nasal discharge, and coughing. However, occasionally lesions may become large enough to result in a degree of respiratory obstruction (Rush and Mair 2004).
- Extraluminal mass (Figs. 3 & 4)– Compression of the dorsal nasopharynx can arise due to an extraluminal disease process such as severe lymph node abscessation related to *Streptococcus equi var equi* (‘Strangles’) infection and guttural pouch haemorrhage, empyema, tympany or neoplasia (Sweeney 1996, Blazyczek et al. 2004).

Larynx

Laryngeal obstruction may be anatomical or functional and either primary or secondary to systemic disease.

- Subepiglottic cyst (Fig. 5)– Horses with a subepiglottic cyst may be asymptomatic, though common clinical signs include coughing, nasal discharge and increased respiratory noise (Aitken and Parente 2011, Salz et al. 2013). Acute collapse has been reported after swallowing of the cyst resulted in laryngeal obstruction and asphyxiation (Hay et al. 1997).
- Subepiglottic granuloma– Clinical presentations are often similar to those of a subepiglottic cyst. Similarly, respiratory obstruction has been reported to be associated with swallowing the mass (Aitken and Parente 2011).
- Epiglottitis (Fig. 6)– Inflammation of the epiglottal cartilage and mucosa is occasionally reported in racehorses with clinical signs of exercise intolerance and increased respiratory noise, though severe cases may demonstrate dyspnoea (Hawkins and Tulleners 1994, Davenport-Goodall and Parente 2003).
- Arytenoid chondropathy (Fig. 7)– Both unilateral and bilateral disease can result in significant reduction in the rima glottidis due to swelling and immobility of the affected arytenoid(s) (Fulton et al. 2012). An infectious process is usually implicated, though granulomatous tissue formation and generalised inflammation also contribute to the obstruction (Fig. 8).
- Bilateral laryngeal dysfunction– Bilateral recurrent laryngeal dysfunction rarely occurs following general anaesthesia and may be associated with an extended head and neck positioning, or surgical manipulation of the recurrent laryngeal nerves (Abrahamsen et al. 1990, Dixon et al. 1993, Dixon et al. 2001). Right sided recurrent laryngeal neuropathy (RLN) has been reported to cause acute respiratory distress following a laryngoplasty for left sided RLN (Canada et al 2017). Bilateral laryngeal dysfunction may also occur in association with hepatic disease, toxicity (including lead and organophosphates) and hyperkalaemic periodic paralysis (Duncan and Brook 1985, Carr et al. 1996, Allen 2010)

- Laryngeal oedema– Endotracheal and nasotracheal intubation may result in laryngeal trauma and oedema, particularly on the medial aspect of the arytenoids (Trim 1984, Heath et al. 1989, Bradbury et al. 2008). Laryngeal surgery may also result in a degree of local inflammation (Cramp et al. 2014). Laryngeal swelling can also occur during anaphylactic reactions and may be combined with other respiratory tract pathology such as bronchoconstriction (Mealey and Long 2018).
- Laryngeal neoplasia– Neoplastic disease is rarely identified in the equine larynx but may result in reduction of the rima glottidis. A number of cellular origins have been reported in equine laryngeal neoplasia including squamous cell carcinoma, neuroendocrine tumours and lymphosarcoma (Jones 1994, van den Wollenberg et al. 2002, Rush and Mair 2004, Koenig et al. 2012).
- Foreign body (Fig. 9)– Laryngeal foreign bodies are rare, as material is typically dislodged into the pharynx by coughing or passes through the rima glottidis to enter the trachea. Occasionally foreign bodies can get lodged in the laryngeal ventricles.

Trachea

The trachea is less commonly implicated but disease may be related to intraluminal obstruction or extraluminal compression.

- Tracheal collapse (Fig. 10)– Congenital tracheal deformities have been reported in horses and donkeys but are most commonly identified in Shetland ponies and miniature horses (Mair and Lane 1990, Aleman et al. 2008, Powell et al. 2010). Most cases present as mature animals with coughing and increased respiratory noise, though some may develop respiratory distress (Aleman et al. 2008). Disruption of the tracheal cartilages during tracheostomy procedure could predispose to tracheal collapse. Tracheobronchopathia osteochondroplastica has also been reported in a pony with acute onset tracheal collapse and rupture (Spanton et al. 2008).
- Trauma– Disruption of the tracheal cartilages can cause acute respiratory obstruction. Wounds are typically present, though in cases of blunt trauma

subcutaneous emphysema may be the only localising sign. Dyspnoea is identified in some cases, usually due to inspiratory collapse of wound margins into the tracheal lumen (Mair and Lane 2010). Cervical cellulitis can progress to result in pyrexia, pneumomediastinum and pneumothorax (Caron and Townsend 1984, Stick 2012).

- Tracheal stenosis– Stenosis generally occurs as a rare complication following tracheotomy or tracheal wounds when scar tissue develops across the lumen (Stick 2012, Barnett et al. 2015). Excessive granulation tissue that develops at sites of tracheal surgery can also obstruct the lumen (Yovich and Stashak 1984).
- Tracheal foreign body– Plant material is the most frequently reported tracheal foreign body (Urquhart et al. 1981, Brown and Collier 1983, Bodecek et al. 2011). These objects can become lodged and result in paroxysmal coughing but are rarely large enough to cause respiratory obstruction. The foreign body may enter the bronchi and lead to pleuropneumonia in chronic cases (Ferrucci et al. 2010, Bodecek et al. 2011).
- Intraluminal mass– Neoplastic or granulomatous masses are a rare cause of tracheal obstruction (Lankveld 2001, Collins et al. 2005). Characteristic signs of luminal obstruction such as increased respiratory noise and effort are usually present.
- Extraluminal mass– Compression of the trachea by external masses is rare. Previous reports have implicated a variety of masses, including lipomas, lymph node abscessation and oesophageal diverticula (Yovich and Stashak 1984, Tessier et al. 1996, Gehlen et al. 2010)

Thoracic and systemic disease

Comparable signs of respiratory distress may also arise from intrathoracic disease, which typically requires a different approach to stabilisation and investigation. Consideration should be given to pathology that reduces the residual volume of the thorax or decreases the efficiency of gaseous exchange (Mair and Lane 1996). Potential differential diagnoses may include acute respiratory distress syndrome (ARDS), pneumonia, pneumothorax, diaphragmatic hernia and severe equine asthma syndrome (Mair and Lane 1989, Dixon et al. 1995, Boy and Sweeney 2000, Wilkins and Seahorn 2004). Smoke inhalation may result in a combination of upper respiratory tract, lower respiratory tract and systemic disease (Marsh 2007, McGorum 2017). Other systemic pathology such as toxicity and central nervous system disease may also present with respiratory signs (Mair and Lane 1996). Management of such cases is not discussed further in this article.

Initial management

If the upper respiratory tract is suspected to be the cause of respiratory distress, initial management procedures depend on the severity of distress and the demeanour of the horse at the time of examination. In most cases there is time to perform endoscopy to ascertain the site of obstruction. If an endoscope is not readily available, or if the horse is very distressed, ataxic or even recumbent, emergency treatment should be instigated before diagnostics are performed. Horses can react violently to airway obstruction and may be difficult to restrain. Distress of the patient and increased respiratory effort can exacerbate airway inspiratory pressures, thus worsening the obstruction (McGorum 2017). Generally speaking, light sedation of the distressed patient is beneficial and in the authors' experience, does not make the obstruction worse.

Establishment of a patent airway is a key primary step. Insertion of a nasotracheal tube is a minimally invasive method of achieving an airway, though this is not possible in some circumstances (see section below) and requires an appropriately sized tube and usually, endoscopic guidance. In most first-opinion emergency situations, a quick and effective method of bypassing an upper airway obstruction and forming a patent airway is by performing a tracheotomy and placement of a temporary tracheostomy tube (Dixon 1988). This can be performed in the standing, recumbent or anaesthetised horse.

A temporary alternative to making a surgical tracheostomy is to pass a nasotracheal tube (Fig. 11). Endoscopy is required to first see if the obstruction can be by-passed with the tube and also then greatly facilitates positioning of the tube. Examples of situations where a nasotracheal tube is useful include bilateral laryngeal paralysis, arytenoid chondritis, nasal occlusion due to sinus disease, pharyngeal collapse due to pharyngeal abscessation and some cases of epiglottic-related swelling, if the rima glottidis is accessible. These tubes are generally 50-60 cm long and 10-14mm internal diameter, depending on the age and size of the horse. Using the biopsy channel of the endoscope to topically 'spray' the laryngeal and pharyngeal mucosa with 20-30 ml of lidocaine can reduce the occurrence of the swallowing and laryngospasm as the tube is passed through the pharyngeal/laryngeal lumen, though this step might not be required. Once in position, the tube can be taped to the horse's headcollar (Fig. 12). This temporary solution allows the veterinarian time to discuss the situation with the client and also to make a surgical tracheotomy incision in a more controlled and sterile manner. In cases of nasal passage oedema, administration of intranasal phenylephrine may be sufficient to resolve passive congestion, though placement of a nasopharyngeal tube is sometimes required (Lukasik et al. 1997, Clarke et al. 2014).

Tracheotomy procedure:

1. Positioning the head in a normal resting position and sedating the horse optimises location of the tracheostomy and allows the procedure to be completed promptly. In very urgent cases, some of the preparatory steps may need to be omitted.
2. The preferred location is the ventral midline at the junction between the upper and middle thirds of the neck (or around the 5th tracheal ring). The tracheal rings are palpable at this level. If the tracheotomy is positioned too high, the tube may be occluded when the horse flexes its head and neck. If positioned too low, there is thicker musculature covering the trachea which makes the tracheostomy procedure and replacement of the tube after cleaning more difficult. The oesophagus also courses lateral to the left side of the trachea in the mid-third of the neck and could be damaged at this location. Nonetheless, the position of the tracheostomy may need to be adapted in cases with tracheal pathology. It is preferable for the site to be clipped and aseptically prepared before surgery.

3. Approximately 10ml of local anaesthetic is infiltrated in a 10cm long, linear pattern subcutaneously on the midline at the surgical site using a 21-23G needle (Fig. 13).
4. A 6cm linear skin incision is made on midline using a scalpel blade (Fig. 14). The incision is then extended through the subcutaneous tissue to expose the paired sternothyrohyoideus muscles. The muscles are bluntly separated along the midline along the length of the incision, to expose the underlying trachea (Fig. 15).
5. Two cartilage rings in the centre of the incision are located and the annular ligament between the rings is identified. A scalpel blade is used to gently stab through the annular ligament, parallel to the cartilage rings (i.e. perpendicular to the skin incision- Fig. 16). Audible air flow often occurs at this stage. The ligament incision is then extended 1.5cm bilaterally so that approximately one third of the tracheal circumference is incised. If more than half of the tracheal circumference is incised, there is a small risk of long term tracheal luminal stenosis due to mucosal stricture (Stick 2012). Several important neurovascular structures course along the dorsolateral aspect of the trachea and can be damaged by a very wide incision. The recurrent laryngeal nerve is the most ventrally positioned followed by the common carotid artery and the vagosympathetic trunk, which are located more dorsolaterally.
6. The temporary tracheostomy tube should then be inserted into the trachea (Figs. 17 & 18). A relatively small tube, for example a human tracheostomy tube (internal diameter 9mm) is easier to place in an emergency and is usually preferable to larger tubes at this stage. Care should be taken to ensure the tube is not placed extraluminally into the subcutaneous tissue. Digital guidance is often sufficient to successfully place the tube. However, insertion of loop sutures using a non-absorbable monofilament suture placed through the ventral midline of each tracheal ring on either side of the tracheotomy can assist in placement of the tube and readily identifies the site during future cleaning and tube replacement. There should be obvious air flow with respiration if the tube is positioned correctly. The tube can then be secured with bilateral loop sutures using a non-absorbable monofilament suture or

by tying a loop of conforming bandage around the neck. In a field emergency situation, the clinician may not have a tracheotomy tube available. Simply making the incision in the annular ligament will allow some airflow, and the rings can be digitally held apart whilst a suitable tube-like structure is sourced.

Temporary tracheostomy tubes:

A range of designs are available for use in a tracheostomy, including metal and plastic tubes. For horses, commercially available semi-rigid silicone tubes, typically with an internal diameter of approximately 17mm are ideal for short to medium term use (Fig. 19). These tubes are also preferable for cases requiring inhalational anaesthesia as they often incorporate an inflatable cuff, a Murphy’s eye and a funnel adaptor for attachment to a breathing circuit. In the emergency case, even a relatively small diameter tube (for example a human tracheostomy tube with internal diameter 9mm) is sufficient to alleviate respiratory distress. A small temporary tracheostomy pack (Fig. 20) is an inexpensive and compact kit for ambulatory practitioners to carry in the car or to have prepared in locations around a clinic. If a purpose made tracheostomy tube is not available, improvised options can include a cut 10 or 20ml syringe casing, a section of stomach tube, a clean section of hosepipe, or the cut handle of a 5-litre plastic container (Dixon 1988, Reed et al. 2007).

Management of the temporary tracheostomy:

Tracheostomy sites rapidly accumulate secretions and exudate. Therefore, daily removal and cleaning of the tube and twice daily cleaning of the site and is recommended (Stick, 2012). Application of petroleum jelly onto the skin along the ventral cervical midline, caudal to the incision can minimise skin scalding and ease cleaning. Temporary occlusion of the tracheostomy tube can be performed to assess the degree of nasal airflow before it is removed. Once the tube is no longer required, it can be removed and the wound left to heal by secondary intention. This typically occurs within 3-4 weeks (Rush and Mair 2004). Long-term cosmetic outcome is usually good, though a scar is sometimes visible or palpable at the surgery site.

Further investigation of emergency upper airway obstruction

Following stabilisation of the patient, further investigation can be performed to confirm diagnosis and guide additional management. Endoscopy is the most valuable procedure in the investigation of obstruction at all levels of the upper respiratory tract and some cases may be amenable to transendoscopic treatment. Radiography of the nasal cavity and paranasal sinuses is commonly used and is especially applicable for the assessment of trauma and neoplasia. Intraluminal gas can delineate foreign bodies and luminal obstruction on pharyngeal or tracheal radiographs but these would normally be more easily visualised on an endoscopic exam. Ultrasonography can also have applications in assessment of the pharynx, larynx and trachea. In some cases advanced diagnostic imaging, such as computed tomography may be valuable. Obstruction secondary to systemic disease may require additional investigation of other body systems to evaluate the primary disease process.

Additional treatment

After stabilisation, additional therapy may include further empirical management such as oxygen insufflation. Beyond this, specific treatment protocols will vary depending on the pathology present but often require a combination of medical and surgical intervention. In many cases referral to a hospital facility may be preferable to permit treatment and on-going management. Several patient and practical factors should be considered prior to travel. It is important that a patent airway has been established and steps have been taken to minimise the risk of recurrence of obstruction during travel. Other practical considerations include the availability of suitable transport, experience of the transporter and distance to the referral centre. Inspecting the horse compartment of the vehicle can be useful to address any features which may compromise airway patency, for example positioning of breast bars or ropes that could dislodge a tracheostomy tube. In this situation, it is usually preferable to travel the horse without feed being available.

Repeat obstruction may be a risk in some patients, especially those with marked upper respiratory tract inflammation. In these cases, potent anti-inflammatory medications are important and may include systemic corticosteroids and non-steroidal anti-inflammatory drugs and topical medication such as ‘throat spray’- usually composed of dexamethasone, dimethyl sulfoxide and glycerol (Brandenberger et al. 2017).

Some cases of severe respiratory tract obstruction may result in the formation of negative pressure pulmonary oedema and even a degree of pulmonary haemorrhage (Abrahamsen et al. 1990). This may result in the production of a pink frothy nasal discharge and persistent dyspnoea, even following bypass of the primary obstruction. Further prompt treatment is imperative and may include oxygen insufflation, suction of fluid from the airways, furosemide, sedation, corticosteroids and non-steroidal anti-inflammatory medication (Senior 2005).

Prevention

In a small number of cases respiratory obstruction may be anticipated. This generally pertains to elective surgical procedures where intra- or post-operative obstruction are likely, for example after arytenoidectomy. Pre-emptive tracheostomy or nasotracheal intubation is preferable in these cases.

Conclusions

Acute upper respiratory tract obstructions are a relatively infrequently encountered emergency in equine practice. A wide spectrum of differential diagnoses can be implicated, and it is important that the clinician is aware of these. However, a small number of methodical steps can result in successful management of the majority of these cases: establishing a patent airway is the most important component, typically by passage of a nasotracheal tube or via a surgical tracheotomy. Once the patient has been stabilised the clinician has more time to evaluate the horse and arrange a referral if necessary or confirm the diagnosis and establish a treatment plan.

Figure Captions

Fig. 1- Endoscopic image demonstrating reduction in the lumen of the nasal cavity due to mucosal oedema and purulent drainage from ipsilateral paranasal sinusitis. The endoscope is positioned at the junction of the middle meatus (green arrow) and the common meatus (red arrows).

Fig. 2- Endoscopic image of choanal atresia. The caudal aspect of the nasal cavity is visualised, with the ethmoturbinates located dorsally (green arrow) and the mucosa of the floor of the cavity ventrally (red arrow). A membranous division is present between the nasal cavity and the pharynx, obscuring the lumen (blue arrow).

Fig. 3- Endoscopic image of a horse with bilateral guttural pouch empyema. Note the ventral collapse of the dorsal pharynx (red arrows) reducing the pharyngeal lumen and obscuring visualisation of the rima glottidis of the larynx.

Fig. 4- Lateral radiograph of the caudal skull and cranial cervical region in a horse with severe abscessation within the guttural pouch following *Streptococcus equi var equi*. infection. There is ventral displacement of the dorsal pharyngeal wall (red arrows) with a significant reduction in the radiolucent airway lumen. The tip of the epiglottis (blue arrow) and laryngeal ventricles (green arrow) are also readily identifiable.

Fig. 5- Endoscopic image of a subepiglottic cyst (green arrows). The epiglottis is displaced dorsally (red arrow). Asphyxiation has been reported in cases where the cyst is swallowed resulting in airway obstruction.

Fig. 6- An endoscopic image of epiglottitis and associated peri-epiglottic inflammation. The epiglottis is partially retroverted, with the tip displaced dorsally (green arrow). There is marked inflammation of the epiglottis and subepiglottic tissue (blue arrow), which is adjacent to the caudal border of the soft palate (green arrow).

Fig. 7- Endoscopic image of a horse with arytenoid chondritis following a laryngoplasty. Note the generalised enlargement of the left arytenoid, which is displaced medially at rest (blue arrow).

Fig. 8- An endoscopic image of a horse with marked bilateral arytenoid chondropathy. The lateral border of the right corniculate is visible (red arrow). Proliferative granulomatous tissue formation has formed on the medial aspects of both arytenoid cartilages (green arrows), obscuring the rima glottidis.

Fig. 9- An endoscopic image of a laryngeal foreign body. Plant material is typically implicated in cases of pharyngeal, laryngeal and tracheal foreign bodies.

Fig. 10- Endoscopic image of tracheal collapse due to congenitally abnormal tracheal cartilages.

Fig. 11- Endoscopic image of a larynx with a nasotracheal tube in place. Endoscopic guidance can be very helpful in placement of nasotracheal tubes.

Fig. 12- A horse with nasotracheal tube in place. Tape has been wrapped around the tube and secured to the headcollar.

Fig. 13- Prior to tracheotomy, approximately 10ml of local anaesthetic is infiltrated in a 10cm long, linear pattern subcutaneously on the midline at the surgical site using a 21-23G needle.

Fig. 14- To begin the tracheotomy a 6cm linear skin incision is made on the ventral cervical midline using a scalpel blade.

Fig. 15- The paired sternothyrohyoideus muscles are exposed and bluntly separated along the midline to expose the underlying trachea.

Fig. 16- Two cartilage rings in the centre of the incision are located and the annular ligament between the rings is identified. A scalpel blade is used to stab through the annular ligament, parallel to the cartilage rings.

Fig. 17- Endoscopic image of a 9mm internal diameter tracheostomy tube in-situ following emergency tracheotomy.

Fig. 18- A horse with a temporary tracheostomy with a silicone tracheostomy tube in-situ.

Fig. 19- An example of a semi-rigid silicone tracheostomy tube, with an internal diameter of approximately 17mm, which is ideal for short to medium term use, including for anaesthesia.

Fig. 20- A compact temporary tracheostomy kit can easily be assembled for use in an emergency. This should include the important items required to prepare the surgical site and perform the procedure: (A) Local anaesthetic, 21G needles, a 10ml syringe and sterile gloves. (B) Scalpel blades, sterile swabs and a commercially available human temporary tracheostomy tube. (C) Conforming bandage and 3.5 metric non-absorbable suture material. Other items for preparation such as clippers and surgical scrub are usually readily available.

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