Complications of orotracheal intubation in the horse

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Abstract

Difficulty to extubate any patient is not a problem commonly thought of during general anaesthesia. This case report describes some of the factors that lead to this predicament and the successful surgical removal of the endotracheal tube via a tracheostomy. This case report also highlights some of the deficiencies in the clinical practice of veterinary anaesthesia. Further research is required for the selection size criteria of endotracheal tubes in all species and the monitoring of cuff pressures during general anaesthesia.

Main Document

Introduction

This clinical case study describes the highly unusual situation where a horse was not able to be extubated without the aid of a tracheostomy assisted extubation. A similar case study has been described in the dog where extubation was assisted via a tracheostomy (Grzywa & Barker, 2022). It is interesting to note that the majority of similar case reports describe the use of either silicone (Romano & Portela, 2020; Sanchis Mora & Seymour, 2011) or red rubber tubes (Grzywa & Barker, 2022). There was one report in a cat where a reused polyvinyl chloride tube was difficult to remove and required the instillation of extra lubrication around the ET cuff (Norgate & Jimenez, 2017). The cuff in this instance was bunched-up thus increasing the effective outer diameter of the ET tube. Could the wider cuff profile of high-volume, low-pressure polyvinyl chloride endotracheal tubes encourage people to use smaller tubes? This is something I have observed in several university clinical practices however it is hard to estimate how it influences general veterinary practice.

This clinical case study not only describes the situation associated with the ET tube becoming lodged in the trachea but also how the authors achieved the successful removal of the ET tube. Both aspects have clinical relevance to practitioners of anaesthesia. Some of the clinically pertinent aspects of this case study will be discussed in further detail below, followed by clinical recommendations.

Endotracheal tube size selection

Investigators have tried to use anatomical predictors for endotracheal tube selection in the dog however none of these methods have been found to be accurate (Tong & Pang, 2019). There are recommendations for endotracheal tube selection in adult humans as well as for paediatric patients (Karmali & Rose, 2020; Miller et al., 2014). It is interesting to note that the recommended inner diameter endotracheal tube size for human adults is approximately 50 to 60% of the tracheal at the level of the cricoid assuming the average tracheal diameter at this point (Karmali & Rose, 2020). There are differences in outer diameter dimensions based upon the different manufacturers of endotracheal tubes and this may come into play when selecting an appropriate size of endotracheal tube. (Karmali & Rose, 2020).

There are currently no recommended endotracheal tube selection criteria for horses. The large variety of horse breeds and chondrodysplastic breeds make this difficult. The large tidal volumes required for horses, encourage the use of the largest endotracheal tube possible to facilitate the use of mechanical ventilation.

Using relatively small endotracheal tubes (c.f. human recommendations) may result in increases in airway resistance and reductions in the alveolar minute ventilation and subsequently cause elevations in $PaCO_2$. Another issue is the higher cuff pressures in these relatively smaller silicone endotracheal tubes could result in higher tracheal-cuff interface pressure, especially with overinflation (Richardson & McMillan, 2017). This needs further research into what is the idea endotracheal tube size that does not injure the respiratory tract and can still facilitate ventilation.

How to assess the adequate amount of air in an ET tube cuff

The authors of this clinical case report describe palpating the pilot balloon to assess the pressure within the endotracheal tube cuff. This technique has been reported elsewhere and the limitations of this technique has been described (Briganti, Portela, Barsotti, Romano, & Breghi, 2012; Veen & Grauw, 2022). Perhaps more sensitive techniques such as auscultation over the larynx (Burns, 2020) or the use of mechanical ventilation (Ferreira, Allen, De Gasperi, Buhr, & Morello, 2021) would be a better alternative. The latter is based on the fact a mechanical ventilator will not cycle properly until there is an adequate seal around the endotracheal tube cuff. Spirometry is another modality that could be used for this purposed based upon this author's clinical experience in both small and large animal practice. In small animals, I have detected differences between an unsealed and sealed endotracheal tube cuff using as little as 0.2mL of air injected into the cuff based upon the pressure-volume loop. Unfortunately, there is only one large animal anaesthetic machine that has this capability11Tafonius, Hallowell EMC, Pittsfield, MA 01201, USA. There is no current consensus on the verification of the adequacy of a seal between the ET tube cuff and tracheal wall.

The importance of lubrication

The use of lubrication gel is commonly applied to endotracheal tube to both help facilitate the passage of the tube through the glottal opening and to aid with the formation of a seal around the endotracheal tube cuff and the tracheal wall (Nishioka, Usuda, Hirabayashi, Maruyama, & Andoh, 2017). The instillation of lubrication gel has also been instilled to help remove endotracheal tubes that were stuck in the trachea (Romano & Portela, 2020) as was the case in this report. Lubrication gel also helps minimize the risk of the endotracheal tube 'sticking' to the tracheal mucosa. I have observed this during my clinical practice, especially with nasotracheal tube placement. In this case, the authors speculate that the tight fit of the endotracheal tube resulting in oedema formation at the location of the cuff. Dorsal recumbency would have contributed to this risk due to the increase in hydrostatic pressures (Binetti et al., 2018). Once these changes occur, it can very difficult to remove an endotracheal tube as evident by the efforts of the authors of this case study and other techniques used to help minimize this tracheal swelling, including the instillation of adrenaline (Grzywa & Barker, 2022). It is interesting to note that the use of benzodiazepines and neuromuscular blockers (Grzywa & Barker, 2022) have also failed to induce tracheal relaxation in other reported clinical situations.

Effect of body position

As mentioned above, placing a horse in dorsal recumbency will lead to increases in hydrostatic pressure within the tracheal mucosa. This is especially true for the Trendelenburg position. This effect could contribute to the formation of tracheal oedema thus increasing the tracheal-cuff interface pressure. Another effect of body position is the degree of neck flexion and how it impacts endotracheal cuff pressures (J. H. Park, Lee, Lee, & Kim, 2021; S. Park, Kwon, & Kim, 2023; Seol, Jin, Oh, Byun, & Jeon, 2022). Changes in neck position will change the cuff pressure. This effect was greater in tapered cuffs as compared to cylindrical shaped cuffs (J. H. Park et al., 2021; Seol et al., 2022). It is interesting to speculate what would have been the effect of neck flexion on the "tight' fit of the endotracheal tube in this clinical case since theoretically this should lead to longitudinal shortening of the tracheal and a slight increase in diameter of the tracheal.

Clinical recommendations to minimise problems with associated with the use of endotracheal tubes.

- Pressure-check the endotracheal tube prior to use to assess for leaks and problems with the pilot balloon (Merlin & Mileham, 2020). This is especially true for reused endotracheal tubes.

- Use auscultation to aid in the detect of the minimal occlusive pressure of the endotracheal tube cuff.
- Check the intracuff pressure after the first ten minutes of anaesthesia to avoid reductions in the cuff pressure and potential micro-leaks (Shin et al., 2018).
- Monitor the cuff pressure whenever the position of the neck has been changed.
- Appreciate that it is possible to have a problem with the pilot balloon or the inflation channel (Merlin & Mileham, 2020).
- Consider using a manometer to assist in monitoring cuff pressures.
- Consider replacing any ET tube that feels 'snug' during an initial intubation.

Further recommendations can be reviewed at a previous clinical commentary (Burns, 2020).

The clinical case reports such as this one, are important to disseminate to the rest of the veterinary community. Not only have these authors described the successful treatment of an anaesthesia associated complication; this report also highlights some deficiencies that are present in our anaesthetic management of tracheal intubation. Further research into endotracheal tube selection and verification of cuff seal are required.

Declarations

The author has no conflicts of interests to declare.

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