Short communication

Training of Upper Respiratory Endoscopy in the Horse Using Preserved Head and Neck

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Summary

Endoscopy of the upper respiratory tract (URT) is one of the minimally invasive techniques used for diagnosis and treatment of diseases in horses. Training in the use of an endoscope follows an apprenticeship approach, with extensive practice needed to help achieve effective skills acquisition. The use of live animals for training presents the risk of injury to both the animal and the trainee. The increased number of students and practitioners, a shortage of facilities and limited time available from expert clinicians add more challenges to the training process. In this work, we focused on the development of a preserved head and neck model that can be used as an effective training tool for training novices in the basics of URT endoscopy. The aim of the training is to become familiar with handling the endoscope and identification of the endoscopic depictions of normal anatomical structures encountered in the URT. Using the model, anatomical structures were clearly visible, recognized by their shape, architecture and topographical location. The model solved many of the aforementioned practical challenges and has great potential as a replacement alternative to the use of live animals. There are opportunities for the application of such models in training other clinical skills and for a variety of species.

Keywords: veterinary training, alternative model, replacement, respiratory endoscopy, horse anatomy

1 Introduction

With rapid advances in technology for diagnostic and therapeutic techniques, there is an ongoing need for training in these imaging modalities. Endoscopy is one of the minimally invasive techniques used for diagnosis and in some cases therapeutic work in many upper respiratory tract (URT) diseases in horses. Training in the use of an endoscope follows an apprenticeship approach, with extensive practice needed to help achieve effective skills acquisition. However, there are many limitations and risks in using live animals for training. The use of replacement alternatives that can provide the same anatomical findings and maneuvers for using the endoscope can be of great help for the animals and trainees. A number of alternatives for use within clinical skills and surgery training have been developed using plastic, plastinated models and virtual reality software (Triantafyllou et al., 2014). Here, a new model using an innovative preservation technique was developed (Elnady, 2015).

2 Materials and methods

Specimen preparation
The head and neck of a horse suffering from terminal disease were obtained following humane euthanasia. A newly developed modified plastination method, the "Elnady Technique", was used to preserve the specimens (Elnady, 2015).

Conventional plastination uses formalin for tissue fixation, acetone or alcohol for dehydration, various types of silicone polymer for impregnation, and gas, light or heat, depending on

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the polymer used, for curing. The Elnady Technique also involves fixation and dehydration, but employs a new non-silicone viscous polymer for impregnation (from BIODUR®, Germany) and follows a different curing process. In our preservation method, all processes run at room temperature.

The Elnady Technique is registered for patency in Egypt (#2051/2014). The patent refers to the chemicals used for impregnation and curing. When the technique is fully published it can be adopted in all countries for non-commercial use. More information is available at https://www.youtube.com/watch?v=UVe9j7L-eOg and http://scholar.cu.edu.eg/felnady/files/fe_catalogue_0.pdf

The specimen was injected with 10% formalin solution through the common carotid artery, after which the artery was clamped and left for one week. The head and neck were separated from the horse's body at the base of the neck. For the process of dehydration, the head and neck were injected with two liters of acetone at 99.9% concentration into the common carotid arteries on either side of the head until resistance of injection was found. It was then clamped and left for three days in an acetone bath of the same concentration. This process of acetone injection was repeated twice with an interval of three days. Using an acetone-meter, the concentration in the acetone bath was frequently measured until it became constant at a level of 95%. The dehydrated specimen was allowed to drain of acetone, and it was then immersed into a non-silicone viscous polymer for two weeks for impregnation. After this period, the specimen was exteriorized from the polymer. For the curing process, the specimen was allowed to drain, wiped carefully with tissue paper, and left in the open air for three weeks to dry thoroughly. It was then ready for use in endoscopy training.

Endoscopy training

The preserved head and neck model was transferred to the Surgery Clinic, Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University for endoscopy. The endoscope used for examination was a 3-meter long, 11-mm diameter horse flexible video-endoscope (Eickemyer 3000 Vmec, Germany).

Four professors and seven postgraduate students performed endoscopy with the head placed into two different positions: lateral and upright (Fig. 1A). The endoscope was held and gently inserted into one of the horse's nostrils. It was then advanced into the nasal cavity of the specimen through the ventral nasal meatus (Fig. 1B). By following the position of the endoscope tip on the screen, the endoscope was guided to avoid passage into the middle or common nasal meatus and slowly advanced on to the nasopharynx, larynx and trachea.

Within the nasopharynx, the endoscope was also advanced into the pharyngeal openings of the Eustachian tubes and into the guttural pouches. Advancing the endoscope into the laryngeal cavity leads into the tracheal lumen (Fig. 1G). To view structures in their correct anatomical directions and positions, the endoscope was rotated regularly. The examination was displayed on the screen. The training on endoscopic examination was carried out in accordance with earlier studies (Traub-Dorgatz and Brown, 1997; Murray, 2002; Cetinkaya et al., 2013).

3 Results

The nasal cavity was clearly visualized on the screen, demonstrating structures such as the nasal septum, dorsal nasal concha, ventral nasal conchae, dorsal nasal meatus, middle nasal meatus, ventral nasal meatus and common nasal meatus.

At the caudal end of the nasal cavity, approaching the nasopharynx, the trainer directs the tip of the endoscope dorsally to view the ethmoidal conchae (endoturbinate II, III and IV) with ethmoidal meatuses in between. The nasomaxillary orifice (the sinus drainage angle) could also be visualized (Fig. 1C).

Within the nasopharynx, the soft palate, epiglottis, corniculate cartilages, vocal cords, arytenoid cartilages, lateral laryngeal ventricles and rima glottides were clearly visualized during examination of the preserved model (Fig. 1D,E).

The two pharyngeal openings of the auditory tube appeared clearly in the nasopharynx, covered with the cartilaginous flaps (salpingiopharyngeal folds). Each ostium leads into a guttural pouch. The endoscope was advanced into the ostium of the guttural pouch. The biopsy channel of the endoscope was used as a pathway for the metal biopsy forceps, with its jaws closed, in order to guide the tip of the endoscope to elevate the fibrocartilagenous flap and advance through the ostium into the guttural pouch (Fig. 1F).

The preserved model has been stored at room temperature for more than one year, and the preservation technique has maintained it in good condition. It has been used successfully several times during this period by trainees for training on URT endoscopy. Washing of the model should be avoided.

4 Discussion

The frequently used live animal methods for training novices on URT endoscopy in the horse is risky and can cause significant harm to the animal. Improper URT endoscopy can cause epistaxis due to trauma of the delicate mucous membrane of the nasal cavity, which has a rich blood supply. In addition, there is the inevitable internal hemorrhage (Fig. 1A) and risk of trauma of vital structures, vessels and nerves related to the guttural pouch during its examination. The horse under examination is often exposed to pain due to twitching.

The use of live animals for training also presents the risk of injury to the trainee. Harmful animal use may also cause desensitization in trainees and encourage an acceptance of the instrumental use of animals. Some practitioners may regret the harmful use of animals that took place in their own training, including the lack of access to innovative non-animal methods and to clinical learning opportunities centered on patient care (Martinsen and Jukes, 2005).

In this study, we developed a preserved horse's head and neck model that was effective for training of URT endoscopy. Since training was applied on a preserved model, there is no pain, nor sedation, nor related complications. The system is also cost-effective, due to the resilience and reusability of the model and the absence of sedative use. Sedatives are necessary before regular endoscopic examination in live animals to facilitate extended

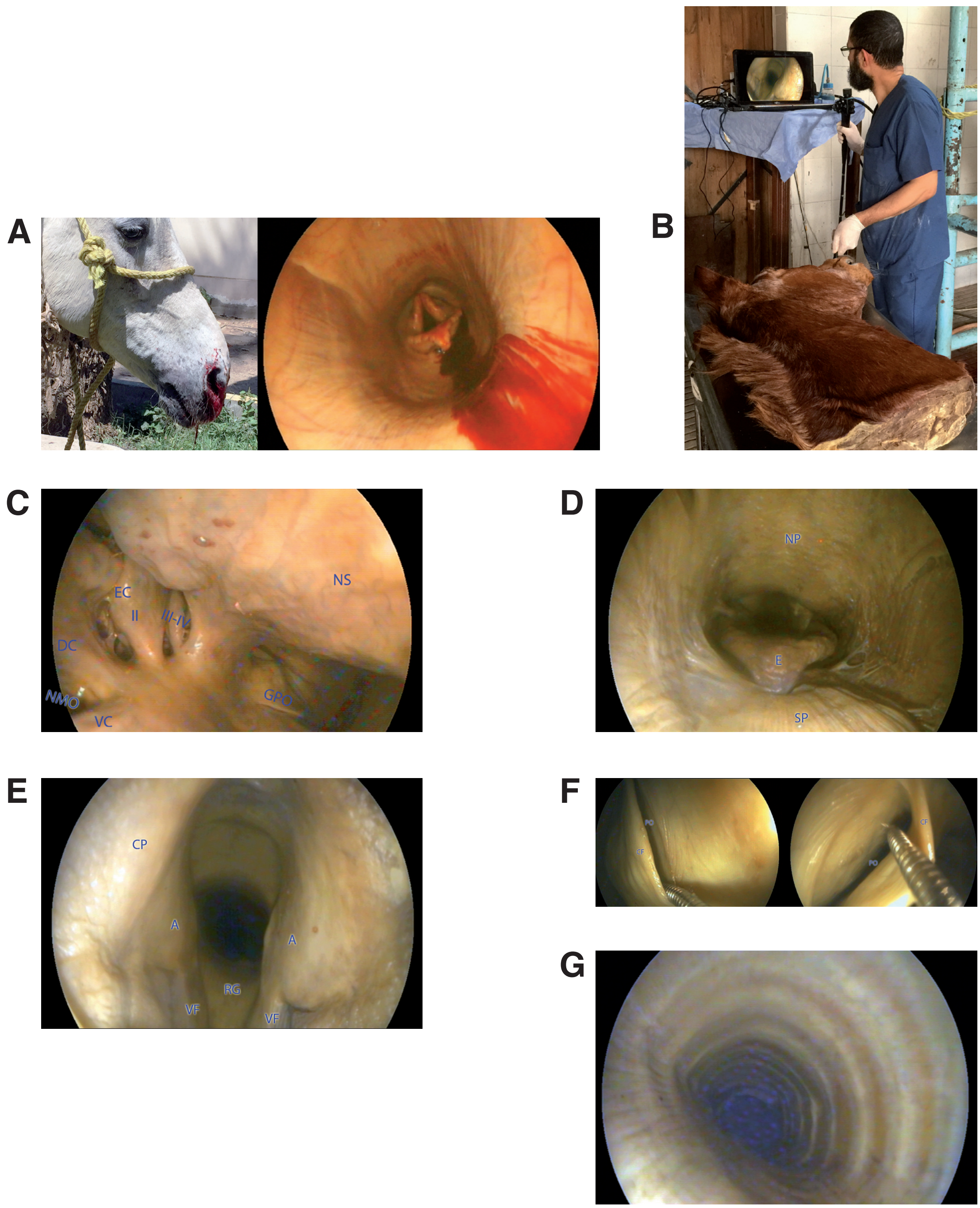

Fig. 1: Images illustrating the use of the head and neck model
A, Traumatic damage to the mucosa of the nasal cavity leading to epistaxis (left), and endoscopic image showing blood flow into the nasopharynx (right) in a horse used for training on upper respiratory endoscopy; B, Preserved head and neck of a horse, used for training of upper respiratory endoscopy; C, Endoscopic image showing the dorsal nasal concha (DC), ventral nasal concha (VC), nasomaxillary orifice (NMO), ethmoidal conchae (EC) (II-III& IV), nasal septum (NS), and guttural pouch ostium (GPO); D, Endoscopic image showing the nasopharynx NP, the soft palate SP, and the epiglottis E; E, Endoscopic image showing rima glottides of the larynx (RG), the corniculate processes (CP), arytenoid cartilages (A), and vocal folds (VF); F, Endoscopic image showing how to introduce the endoscope into the guttural pouch guided by a metal biopsy forceps advanced through the endoscope biopsy channel (left picture). Elevation of the fibrocartilage flap (CF) (salpingeopharyngeal fold) that closes the pharyngeal opening of the auditory tube (PO) (right picture); G, Endoscopic view showing tracheal lumen and the tracheal cartilaginous rings

examination and ease of advancing the endoscope through the nasopharynx (Traub-Dorgatz and Brown, 1997; Slovis, 2004; Barakzai, 2007).

There were some variations from the live animal, including color of the mucous membrane, which appeared pale compared to the highly vascularized one in live animals. Future models could be injected with red colored latex to mimic the real appearance of the mucous membrane in live animals.

However, this does not affect the training process, as the main objective is to make the trainee familiar with the endoscope and control of its various parts. The second objective met through using the model is interpretation of various anatomical structures encountered during examination by endoscope.

Endoscopic views showing the topographical position, architecture and shape of anatomical structures were similar to those in live animals. The preserved specimen showed some flexibility. Structures were similar to those of live animals during endoscopy, as seen when elevating the cartilaginous flap of the pharyngeal opening of the auditory tube.

Trainees can also spend more time practicing according to their own pace, as observed in alternative models for training clinical skills on a preserved dog model (Janick et al., 1997).

A detailed assessment of student performance and skills retention was not performed, as the current work was focused on production of the model. However, endoscopy experts and the trainees agreed that the model has enhanced training and brought other advantages. In the future, we will develop a project for production of more models for a range of clinical skills and species. These could be used by a large number of students and trainees with an ongoing assessment.

In conclusion, the use of a preserved horse head and neck model has considerable potential to improve the performance of novice endoscopists. The model is safe, more cost effective and more realistic than current plastic or computer-based virtual reality models. It can successfully replace the use of animals in training of horse upper respiratory endoscopy.

References

Barakzai, S. (2007). *Handbook of Equine Respiratory Endoscopy*. 3rd edition. Elsevier.

Cetinkaya, M. A., Demirutku, A. and Kaya, M. (2013). Gastroscopic evaluation of gastric ulcer syndrome in sport horses with poor performance. *Turk J Vet Anim Sci 37*, 541-545. http://dx.doi.org/10.3906/vet-1209-38

Elnady, F. A. (2015). The Elnady Technique: An innovative new method for tissue preservation. Manuscript under preparation.

Janick, L., DeNovo, R. C. and Henry, R. W. (1997). Plastinated canine gastrointestinal tracts used to facilitate teaching of endoscopic technique and anatomy. *Acta Anat (Basel) 158*, 48-53. http://dx.doi.org/10.1159/000147910

Martinsen, S. and Jukes, N. (2005). Towards a humane veterinary education. *J Vet Med Educ 32*, 454-460. http://dx.doi.org/10.3138/jvme.32.4.454

Murray, M. J. (2002). How to perform gastroduodenoscopy. *AAEP Proceedings 48*, 282-286.

Slovis, N. M. (2004). *Atlas of Equine Endoscopy*. St. Louis, Missouri: Mosby.

Traub-Dorgatz, J. L. and Brown, C. M. (1997). *Equine Endoscopy*. 2nd edition. St. Louis, Missouri: Mosby.

Triantafyllou, K., Lazaridis, L. D. and Dimitriadis, G. D. (2014). Virtual reality simulators for gastrointestinal endoscopy training. *World J Gastrointest Endosc 6*, 6-12. http://dx.doi.org/10.4253/wjge.v6.i1.6

Conflict of interests

The authors declare that they have no conflicts of interest.

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