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A blind insertion airway device in dogs as an alternative to traditional endotracheal intubation

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ABSTRACT

Endotracheal intubation is the standard of care to establish a secure airway; however, laryngeal airway management systems are increasingly being used in human patients for elective surgical procedures and in emergency settings. In this study, a double lumen, blind insertion airway device (BIAD) was placed in the esophagus of dogs and evaluated for its ability to ventilate the lungs. Initially, 10 euthanazed dogs were evaluated, followed by a group of 15 mixed breed dogs that were undergoing elective spay or neuter procedures, and a group of 10 healthy dogs. Post-procedure evaluation included visual examination with a laryngoscope to inspect for signs of inflammation or mucosal damage. The device provided adequate ventilation in all subjects; the dogs were under anesthesia or heavily sedated for 10 min to 2 h and recovered uneventfully. No evidence of esophagitis, aspiration pneumonia, tracheitis, subcutaneous emphysema or esophageal laceration was observed. In conclusion, the use of double lumen airway devices warrants further study as an alternative airway management system in dogs.

Introduction

The establishment of a secure airway via endotracheal intubation is the standard of care in veterinary medicine for animals undergoing sedation or anesthesia, or during cardiac-pulmonary-circulatory resuscitation. Endotracheal intubation has considerable advantages in that a direct seal of the tracheal lumen is achieved, the airway is protected from aspiration and oxygen can be delivered without impedance from obstructions within the oropharynx (ECC Committee, 2005; Brainard and Hofmeister, 2012).

In comparison, alternative airway management systems have been used increasingly in human patients for elective surgical procedures and in emergency settings. These systems are known as blind insertion airway devices (BIADs) because visualization of their placement is not necessary to achieve proper placement. Several different airway devices are available, including esophageal obturators, laryngeal masks and oropharyngeal airway devices. An esophageal obturator airway is a tube that is inserted into the esophagus to maintain airway patency in unconscious people during positive pressure ventilation through an attached face mask. A laryngeal mask airway device allows a patent airway to be maintained without tracheal intubation. The device consists of a tube connected to an oval inflatable cuff that seals the larynx. An oropharyngeal airway is a tube inserted through the mouth and pharynx so that the tongue does not block the air flow.

The advantages of esophageal and laryngeal management devices in humans include increased speed and ease of placement by inexperienced personnel, increased speed of placement by anesthetists, improved hemodynamic stability at induction as well as in emergency situations, reduced anesthetic requirements for airway tolerance, lower frequency of coughing, improved oxygen saturation and lower incidence of 'sore throat' in adults (Brimacombe, 1995). However, these devices are not without complications, which can include esophagitis, aspiration pneumonia, tracheitis, subcutaneous emphysema and esophageal lacerations (Vézina et al., 1998).

Complications of endotracheal intubation in both humans and dogs may include aspiration, esophageal intubation, dental injury and pneumothorax. Independent risk factors for complications from intubation include three or more intubation attempts or an inability to place the endotracheal tube (American Society of Anesthesiologists, 1993; Jaber et al., 2006). In emergency situations, the establishment of an airway without interruption of chest compressions is important (Fletcher et al, 2012). The ease and speed of intubation can therefore be a critical consideration when a difficult airway is anticipated.

One esophageal tracheal airway management system for human use, the Combitube (Kendall Sheridan Catheter; Fig. 1), is designed to ventilate the lungs through insertion of a tube into the esophagus. This device can also be utilized with direct tracheal intubation if desired. The Combitube is available in small and large adult sizes, the Combitube 37 F/11.1 mm SA and Combitube 41 F/12.3 mm, respectively. The Combitube is a double lumen system; one lumen resembles an endotracheal airway with a distal opening, while the second lumen resembles an esophageal obturator type

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Fig. 1. The Combitube 37 Fr and 41 Fr sizes.

airway, with the distal end blocked and perforations at the pharyngeal level. The lumens lie alongside one another and are divided by a partition. At the proximal end of the double lumen, two small tubes connect to the pharyngeal and the tracheal pharyngeal lumina.

The pharyngeal balloon is made from an elastic material that seals the patient's mouth and nose. Once inflated, the balloon presses against the base of the tongue in a ventrocaudal direction and closes the soft palate in a dorsocranial direction. The final placement of the tube establishes the ventral proximal wall of the oral pharyngeal balloon, which is positioned just behind the caudal aspect of the hard palate. After insertion, the distal cuff is either in the trachea or in the esophagus and can be inflated to seal the lumen. The oral pharyngeal balloon will anchor the tube in place, making it unnecessary to secure the tube to the muzzle using traditional methods, such as a tie, although ties can still be used to reduce the motion of the tube if desired.

BIADs have been shown to be effective in humans (Frass et al., 1988; Frass, 1996); however, a similar application in dogs has not been widely adopted. We hypothesized that an esophageal tracheal device would provide adequate ventilation and protection of the airway, and seal the oropharynx. We have considered whether this device could be utilized in certain situations where endotracheal intubation is not possible or in difficult airway situations, such as in brachycephalic dogs with elongated soft palates or dogs with facial trauma.

Materials and methods

Pilot study

A pilot study was conducted post-mortem on a 34 kg female Labrador retriever dog to evaluate placement of the Combitube and its ability to inflate the lungs. The dog was humanely euthanased at the owner's request due to health-related issues. Following informed consent to use the dog in the pilot study, the Combitube was placed in both the esophagus and trachea according to the manufacturer's recommendations[1]. Radiographs were obtained to evaluate placement of the Combitube and gastric distension after ventilation with an anesthetic unit (Fig. 2). The pilot study indicated the feasibility of the hypothesis and, therefore, the study was expanded.

[1] See: Combitube package insert. Tyco Kendall Sheridan Catheter Corporation, 1995.

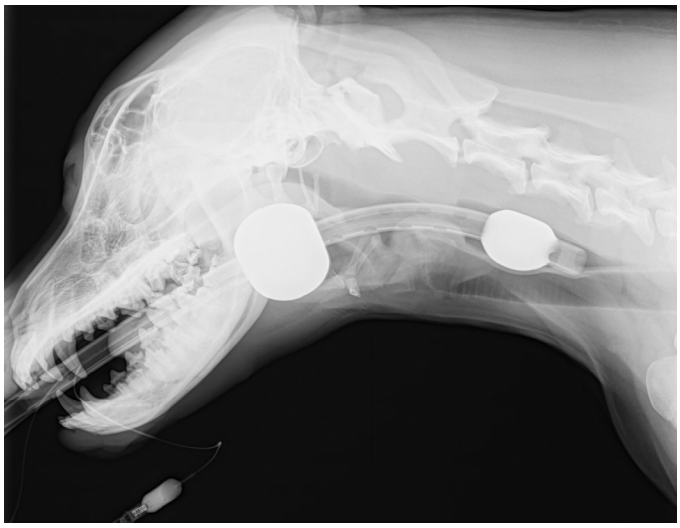

Fig. 2. Radiograph of the Combitube taken for pilot study enhanced using iohexol (Omnipaque, GE Healthcare).

Post-mortem study

Dogs that had been humanely euthanazed for various health-related issues were utilized with the owners' informed consent. To ensure chest compliance was not affected by rigor mortis, testing was initiated within 2 h of euthanasia. Dogs with lung disease or trauma to the lungs, airway, chest wall or oral cavity were excluded. Ten dogs included in the trial weighed 9–45 kg (median 24.6 kg), were 2–12 years old (median 10.5 years old) and were equally distributed by sex (four neutered males, one intact male, four spayed females, one intact female). Breeds included two Shepherd crosses and one each of Pug, Bluetick coonhound, American bulldog, Weimaraner, Jack Russell terrier, Basenji, Beagle cross and Belgian Malinois.

The Combitube was placed into the esophagus in accordance with the manufacturer's recommendations. The esophageal balloon was filled with 15 mL of air for the 37 Fr tube and 20 mL for the 41 Fr tube. The oropharyngeal tube was filled with 2 mL/kg bodyweight of air. Following inflation of the device with air, the quality of seal was tested by applying a positive pressure of 18–25 mm Hg to the rebreathing reservoir and observing if the circuit maintained pressure and could be considered closed. Ventilation was provided via an anesthetic device with a pressure gauge or a ventilator. Quality of inflation and leaks were assessed by at least two veterinarians. Evaluation criteria included auscultation, chest rise, and variance of airway pressure and duration of positive pressure maintenance. Gastric inflation was assessed via palpation. Each subject was assessed on the basis of the ability of the airway device to seal the airway and maintain positive pressure. If pressure of ≥18 mm Hg was not achieved, the test was considered to be a failure. Post-procedure evaluation was by visual examination with a laryngoscope to inspect for signs of mucosal damage.

Live dog study 1

A live animal study was then performed on a group of 15 mixed breed dogs that were undergoing elective spay or neuter procedures at a shelter. Study design and consent for inclusion in the study were obtained by the shelter manager and staff veterinarian. The standard procedure for spay or neuter at this facility did not include endotracheal intubation. The seven male and eight female dogs weighed 9.5–28.3 kg (median 17.4 kg) and were 6 months to 12 years of age (median 2.4 years). Each dog received 0.5 mg/kg morphine SC, 0.025 mg/kg acepromazine SC, 0.55 mg/kg xylazine IV) and 2.7 mg/kg ketamine IV; isoflurane was administered if needed. The Combitube was placed blindly into the esophagus and the manufacturer's recommendations were followed, as previously. The time recorded for the duration of anesthesia began as soon as the tube was inserted and ended when the tube was removed. The time for the surgical procedure was 10 min to 2 h, depending on the dog and the veterinary surgeon performing the procedure. All dogs with a procedure time >10 min received isoflurane.

Ventilation, gastric distension, pulse oximetry (peripheral oxygen saturation, SpO_2; partial pressure of CO_2, PCO_2; total CO_2, tCO_2; partial pressure of O_2, PO_2), end tidal CO_2 ($EtCO_2$) and electrocardiogram were assessed in all dogs for the duration of their procedure. Post-procedure evaluation was by visual examination with a laryngoscope to inspect for signs of inflammation or mucosal damage. Follow-up physical examinations were performed each day post-operatively for 3 days, with specific evaluation of coughing, respiratory difficulty and upper airway distress, but with no advanced diagnostic procedures.