Short Communications

An observational clinical study in cats and rabbits of an anatomically designed supraglottic airway device for use in companion animal veterinary anaesthesia

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IN literature, there are many reports of complications following endotracheal intubation in human patients. Examples include oesophageal perforation (Ranchère and others 1992) and tracheal rupture (Austin 2010). Supraglottic airway devices (SGADs) are frequently used in human anaesthesia, and one such device, the Laryngeal Mask Airway (Intavent, Orthofix, UK), has been used in approximately 150 million anaesthetics (Cook 2003). These devices allow maintenance of anaesthesia without intubation. They have the advantage of easy insertion without the risk of laryngeal or tracheal trauma (Hashmi and others 2009). One such device (the i-gel, Intersurgical, Berkshire, UK) is constructed from a soft thermoplastic elastomer with no inflatable sections to reduce trauma risks and improve patient comfort. This device is used for routine and emergency anaesthesia for human patients. In one study, the i-gel was found to have lower failure rates and complications than other supraglottic devices (Gatward and others 2008).

Endotracheal intubation in cats is associated with an increased risk of anaesthetic-related death (Brodbelt and others 2007). Reported complications of endotracheal intubation in cats include laryngeal (Hofmeister and others 2007), or tracheal trauma, (Wong and Brock 1994, Mitchell and others 2000, Kästner and others 2004, Bhandal and Kuzma 2008), laryngeal spasm, (Brodbelt and others 2007), or lidocaine-induced tissue oedema from topical laryngeal application (Rex and others 1983). Overinflation of endotracheal tube cuffs can cause tracheal rupture (Hardie and others 1999).

Endotracheal intubation in rabbits has been shown to carry a significant risk of tracheal trauma, with the potential for tracheal mucosal necrosis and subsequent airway obstruction and death postoperatively (Phaneuf and others 2006). Iatrogenic tracheitis has been found to be a cause of late postoperative death either as a result of chemical damage from inadequate rinsing after disinfection, or direct physical trauma from the endotracheal tube bevel (Grint and others 2006). Respiratory obstruction has been reported as a cause of death in rabbits (Brodbelt and others 2007); therefore, the maintenance of a patent airway is of great importance. Endotracheal intubation in rabbits is a difficult technique to master (Price, 2007). Blind intubation is one commonly used intubation method in rabbits (Morgan and Glowaski 2007). The highest risk during endotracheal intubation is laryngeal trauma, with subsequent glottis oedema (Balbinotto and others 2010). It would be of value, therefore, to find a method of airway management in rabbits that did not involve the use of an endotracheal tube.

Some SGADs have already been investigated for veterinary use (Bateman and others 2003, Cassu and others 2004, Smith and others 2004, Bateman and others 2005, Goldmann and others 2006, Crotaz 2010). Lingual cyanosis has been noted in rabbits with laryngeal masks, probably due to device pressure on lingual vasculature (Kazakos and others 2007).

The purpose of this pilot study was to demonstrate that the v-gel SGAD devices that had been developed in an earlier ex-vivo study (Crotaz 2010) (Fig 1) worked in a clinical setting for cats and rabbits, and to find areas for design improvement.

This pilot study was run as a collaboration between the author and Dr M Nasir (the inventor of the i-gel human device) and Peter Jassell of Docsinnovent.

Permission for a clinical trial was granted by the Royal College of Veterinary Surgeons Recognised Veterinary Practice Subcommittee, who checked the trial protocols and decided that the study fell within the bounds of clinical veterinary practice (decision reference 08.08-C032). Informed consent for inclusion in the study was gained from owners. Any engineering or shape changes to the v-gel devices were made in collaboration between the author and Peter Jassell.

Procedures were elective (generally neutering procedures), of healthy patients with an American Society of Anesthesiologists (ASA) rating of 1(normal, healthy patient, with no systemic disease) and a low risk of emesis. Patients due to have gastrointestinal or thoracic surgery, or procedures involving oral fluids (dental surgery) and brachycephalic breeds were excluded from the trial. No more than three unsuccessful insertions would be allowed. If insertion was unsuccessful (insertion to correct depth and position without thoracic movement and visible capnograph traces), the v-gel would be removed and replaced with an endotracheal tube. Successful insertion was considered to be an insertion to the correct depth, with normal thoracic movement, no audible upper respiratory noise, and visible capnograph traces matching the respiratory movements.

The v-gel was sterilised prior to each use (autoclave cycle 121°C) and lubricated immediately before insertion with a thin layer of water-based lubricant (KY Jelly, Johnson & Johnson).

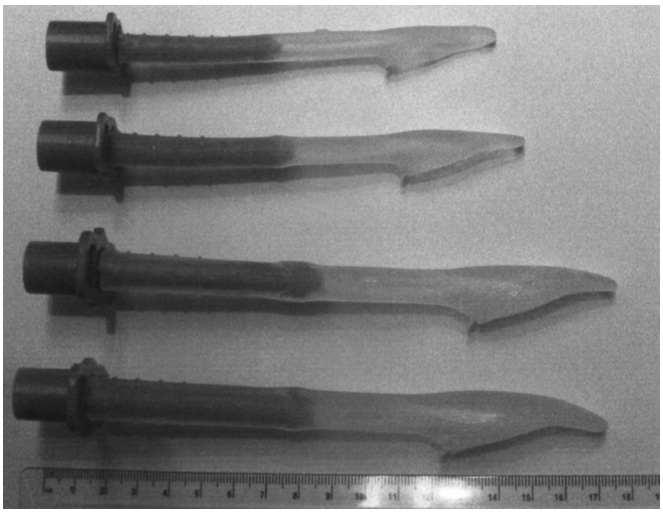

FIG 1: Lateral view, size 1 and 2 rabbit devices (top) and size 1 and 2 cat devices (bottom)

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Preanaesthetic medication consisted of medetomidine and butorphanol administered by intramuscular injection. Anaesthesia was induced using either propofol by intravenous injection in cats, or isoflurane via a facemask in rabbits once a sufficient level of sedation had been already achieved. Prior to insertion, the v-gel was connected to a capnograph (Capnocheck 8401, Burtons, UK). All patients were preoxygenated for three minutes before device insertion. Care was taken to ensure that the patient was adequately anaesthetised, with no limb withdrawal or gag reflexes prior to insertion. The patient was held in sternal recumbency with the neck extended. The oral cavity, pharynx and larynx were checked using a laryngoscope to make sure that they were free from foreign material, and the larynx was desensitised with 2–4 mg (1 spray) of topical lidocaine liquid (Intubeaze, CEVA). Although lidocaine has the potential to cause laryngospasm, this was considered to be an important precaution to reduce the potential for laryngospasm should the v-gel behave unexpectedly. Device insertion was delayed by 45 seconds to allow any lidocaine-associated laryngospasm to resolve. The v-gel was then inserted gently into the oral cavity and then into the pharynx. The v-gel is designed to fit the anatomy of the upper airway and self-guide into position. For this reason, a simple rostral to caudal movement was required for insertion. The end point was determined by the feel of the device and the increase in resistance as the tip of the device entered the proximal oesophagus, as well as the presence of capnograph traces. If a capnograph trace was not immediately obvious, or traces did not perfectly match respiratory movements, the position of the v-gel was gently adjusted rostrally and caudally until capnograph waves were apparent. Insertion time was recorded as the period between the first insertion movement and the first square wave capnograph trace.

The v-gel was then secured using a bandage tie. The v-gel was disconnected from the circuit before repositioning the patient. The v-gel device was removed during the recovery phase, when limb withdrawal reflexes or voluntary movements were observed. Anaesthesia was monitored using clinical monitoring of anaesthetic depth, capnography (Capnocheck 8401, Burtons, UK) and pulse oximetry (PM-50 Veterinary Pulse Oximeter with lingual sensor). Anaesthesia was maintained with isoflurane delivered in oxygen via a Mini-Lack circuit using a flow rate of between 1.5 and 2 litres oxygen/minute.

Subjective observations on the handling characteristics of the device and the quality of recovery were made in order to give feedback for further device development. Pulse oximetry and capnography readings were recorded for the purposes of the study, five minutes after induction of anaesthesia. Close observation was undertaken for the first two hours of the recovery period.

Device insertion and maintenance of gaseous anaesthesia was successful in 54 of the 56 patients (see Table 1). Pharyngeal space for the device was limited in the first and third rabbit patients, and their insertions were aborted and anaesthesia was maintained following blind endotracheal intubation. The rabbit v-gel was then redesigned (see Discussion) which made v-gel use in subsequent rabbit patients easier.

Twenty-seven successful rabbit and 27 successful cat procedures were carried out. Observational data (see Table 1) was used to continuously assess the characteristics of the device and fine tune the handling and support of the device during the procedures. Research data was separated from patient and client details to keep such details confidential.

Mild lingual cyanosis was noted in one of the rabbits and none of the cat procedures (see Discussion). There was no evidence of adverse upper airway reactions or apnoea during v-gel use.

TABLE 1: Median averages of observed parameters from rabbit and cat anaesthetic procedures using the v-gel devices

Observed parameter	Rabbit	Cat
Patient numbers	29	27
Successful insertions with full anaesthesia maintained using v-gel device	27	27
Median time taken to insert v-gel device/seconds	8.0	2.5
Median end tidal CO2/mm Hg	41.5	32.0
Median pulse oximeter reading/%O2 saturation	97	98
Median duration of v-gel placement/minutes	30	20

It was noted that coughing or swallowing were absent from the recovery period (first two hours following anaesthetic recovery) in all patients. Therefore, the swallow reflex could not be used as an indicator for device removal.

Device insertions were faster in cats than in rabbits, as can be seen from comparisons of the insertion times between the two groups (see Discussion).

During this trial, the v-gel devices proved to be easy and rapid to insert in almost all cases. Oxygen saturation readings were consistently good. The quality of recovery of all patients was subjectively smooth and relaxed. Coughing was not observed during recovery. The devices proved simple to autoclave between uses, in order to prevent cross-infection.

It was subjectively found that the rabbit v-gel was more simple and rapid to insert than an endotracheal tube would have been, in the experience of the author. Future research is planned to quantify insertion times and capnometry values when compared against endotracheal intubation. Although insertion times were longer in rabbits than cats, v-gel insertion was still easier and faster in rabbits than blind endotracheal intubation would have been. The cat v-gel was easier to insert which is reflected in the faster insertion times in cats than rabbits.

The rabbit v-gel was redesigned following the unsuccessful insertions, with a scoop of material removed from the dorsal aspect of the oesophageal section. This encouraged the device to flex dorsally during insertion away from the larynx and up into the oesophagus, making subsequent insertions easier.

It took experience to identify the precise stop point of insertion. It was possible to overinsert the v-gel and so reduce the potential airway diameter. Correct positioning was based primarily on the presence or otherwise of capnograph waves. Using the study information, the v-gel devices will be redesigned to make it much easier to identify the correct stop point of insertion.

The v-gel devices had to be carefully supported to prevent rotation while in place, particularly if it became necessary to move the patient. The design factors contributing to this problem have been identified, and improvements will be made to the length and design of the devices to improve stability.

A significant portion of the proximal device was extraoral in the initial prototypes. This allowed for patient size variation, and it is intended to reduce this extraoral length in future prototypes to minimise mechanical dead space. Reducing the device length is also anticipated to increase device stability.

Lingual cyanosis was noted in the later stages of one of the rabbit procedures. In this case, jaw manipulation and repositioning the v-gel reduced the problem although the tongue only returned to normal colour after the device was removed. It was the opinion of the author that this cyanosis was the result of venous congestion rather than arterial compression, and further anatomical studies are planned to investigate this. It proved to be impossible to record pulse oximetry measurements during the period of cyanosis even though non-lingual probe sites were tried (pinna and interdigital readings are frequently unrewarding sites for pulse oximetry measurements in rabbits in the experience of the author). It is also likely that the use of preanaesthetic medication not involving $\alpha 2$ agonists would improve peripheral pulses. Gingival and conjunctival mucous membrane colour remained normal throughout this period and no problems were noted on recovery. The design of the devices is currently being adapted to improve their function and reduce the incidence of these problems.

Although the perilaryngeal seal was assumed to be good, there was no proof that the v-gel would protect against inhalation of instrument-cooling fluids or gastro-oesophageal reflux. The effects of intermittent positive pressure ventilation were not assessed during this study. Future research will address these issues.

This study has demonstrated that it is possible to maintain anaesthesia in a clinical setting using the v-gel SGAD. Both rabbit and cat designs proved to be easy and rapid to insert. Anaesthetic recovery was subjectively observed to be smooth and relaxed without any coughing.

This study will be used as a basis to improve the design of the v-gels for further clinical trials.

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Competing interests The author acts as a veterinary consultant to Docsinnovent, the inventors of the v-gel device.

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