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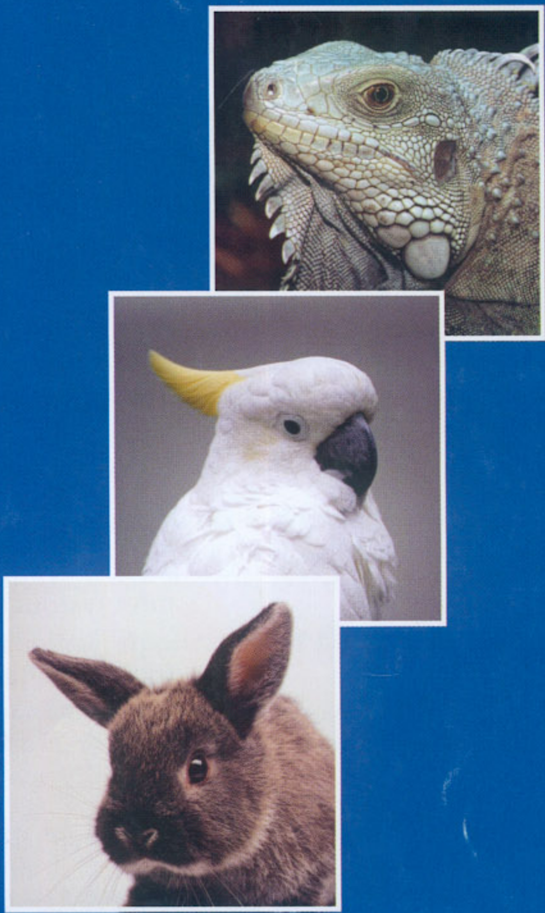

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Tracheal Intubation in Exotic Companion Mammals

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Abstract

Tracheal intubation is a mainstay of anesthesia and critical care in human and traditional pet species patients, and is being used with increasing frequency in exotic patients as well. Because laboratory experimental designs often require inhalant anesthesia, respiratory support, and delivery of drugs via the trachea, intubation is practiced and reported in laboratory animal literature in a variety of exotic pet species, including rats and other rodents. Veterinary practitioners can use a number of these tracheal intubation techniques for patients in private practice. Copyright 2008 Elsevier Inc. All rights reserved.

Key words: **intubation; exotic mammal; blind intubation; nasotracheal intubation; nasal intubation; tracheostomy**

Intubation techniques encompass a wide variety of modalities beyond traditional orotracheal intubation, or introduction of a tube via the oral cavity into the trachea (Table 1). Other modalities include nasal intubation, nasotracheal intubation, and direct tracheal intubation via tracheostomy or temporary tracheostomy.

The selection of the technique is dependent on the overall goal of the desired procedure, species, patient size and clinical condition of the patient, and operator skill and preference. In general, the ideal intubation procedure is rapid and minimally traumatic, allows accurate and adequate delivery of oxygen and/or a desired therapeutic agent in the case of delivery of anesthetic gas, and provides minimal leakage of waste gas into the environment.

Equipment for Tracheal Intubation

Equipment used for tracheal intubation includes nasal or endotracheal tubes and other instruments to facilitate placement. A wide range of endotracheal tube sizes and compositions is readily available (Fig 1). As opposed to a few species of psittacine birds, the size of the trachea in most mammals is conserved along its length, and judgment regarding size can be made based on the diameter of the larynx, which is always slightly narrower than the lumen of the trachea itself. Tubes should be of a diameter that allows for easy advancement, and provides a reasonable seal without producing pressure necrosis of the tracheal epithelium. Smaller, commercially available endotracheal tubes (3.0 mm and smaller) are often supplied as noncuffed. Cuffed tubes of a larger diameter can be used in bigger exotic patients, and one should inflate the cuff with caution, using the same guide-

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Table 1. Modalities and techniques for tracheal intubation as reported in the literature

Modality	Modality Options	Technique	Technique Options	Comments
Tracheal	Orotracheal	Direct visualization of the glottis	With or without laryngoscope;laboratory kits available for rodents	Technique of choice for ferrets and other carnivores; increasing difficulty in smaller herbivorous species
		Indirect visualization of the larynx	Endoscope guided: “side-by-side” or“over the endoscope”	Best option for guinea pigs, chinchillas
		Without visualization of the larynx (“blind”)	Listening technique; visualization of condensation	Described most commonly in the rabbit Listening is extremely difficult in species other than the rabbit, and in rabbits under 2 kg
	Nasotracheal	Blind		
	Direct tracheal	Temporary tracheotomy or tracheostomy		Emergency procedure for rapid airway access; ideal for diseases/selected surgeries of the head and oral cavity
		Permanent tracheostomy		See above; for longer-term maintenance of airway
Nasal	Single nasal tube or double nasal tube	Via nasal opening(s)		For cases in which tracheal intubation is not possible or desired; obligate nasal-breathing species only
	Rhinotomy	Temporary		Option when other routes are not possible, especially severe disease of the nasal cavity
		Permanent		See above; for longer-term maintenance of airway

lines as for traditional pet species. Endotracheal tubes for very small patients are constructed from other materials (e.g., smaller-diameter nasogastric tubes, urinary catheters, intravenous catheter sheaths). Adapters from standard endotracheal tubes may be used with smaller endotracheal tubes for attachment into the main anesthesia line leading to the machine.

Tubes for nasal intubation or direct tracheal intubation of very small patients are constructed from similar materials as mentioned above. Direct tracheal intubation of larger patients can be performed with standard endotracheal tubes.

An important practice tip for veterinarians to remember is that optimal intubation is performed with a tube about two thirds of the diameter of the trachea, or close to the diameter of the glottis. Endotracheal tubes that are of an inappropriate size allow excessive escape of anesthetic gas, thus necessitating higher anesthetic gas concentrations. In these situations, anesthetists often experience difficulty maintaining a consistent, adequate plane of anesthesia. This situation also produces the risk of increased exposure of hospital personnel to waste gas.

In general, the authors prefer standard, noncuffed 2.5-mm endotracheal tubes with a stylette for ferrets, and noncuffed 2–0 to 3–0 tubes without a stylette for rabbits depending on patient size. Tubes selection and use of the cuff or stylette for larger exotic patients (e.g., carnivores, primates) are made based on patient size and personal preference.

Tubes for any purpose or technique should be sterile to very clean, atraumatic, and free of disinfectant or other substances that can produce irritation to the mucosal lining of the trachea. Before any intubation attempt, the patient’s oral cavity should be clear of food or other debris that might be inadvertently pushed into the trachea during the intubation process. This is especially important in the guinea pig, because this species is especially prone to accumulating excess food material in the oral cavity. Removing food from the

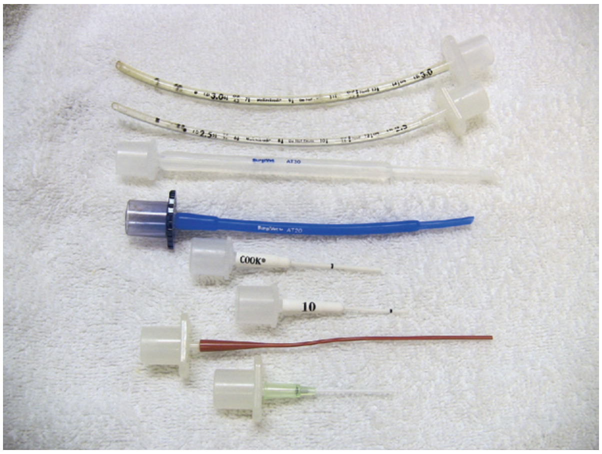

Figure 1. Endotracheal tubes for exotic companion mammal use. Some are commercially manufactured, and some have been adapted from other materials.

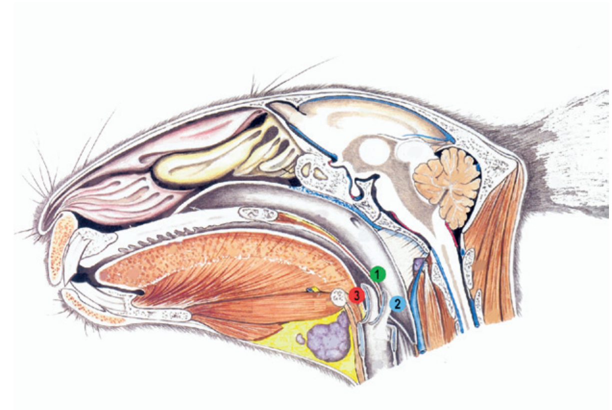

Figure 3. Illustration of the head and upper airway of a rabbit demonstrating the soft palate (*1*), normal physiologic position of the epiglottis (*2*), and displaced position of the epiglottis (*3*) (see Fig 4). Adapted from Popesko P: A Color Atlas of Anatomy of Small Laboratory Animals, Vol. I, with permission.[1]

oral cavity is best accomplished with moistened cotton-tipped applicators.

Techniques for Intubation

Orotracheal Intubation—Direct Visualization of the Glottis

Orotracheal intubation through direct visualization of the glottis is reported most frequently in the veterinary literature with larger carnivorous and omnivorous species (e.g., ferrets, skunks, opossums, foxes). The technique for orotracheal intubation is straightforward and similar to that performed in domestic carnivores (e.g., dogs, cats), with direct visualization of the glottis.[2] In the ferret, the authors prefer a 2.5-mm endotracheal tube with a 30° angle

Figure 2. The Nazzy mouth gag (Universal Surgical Instruments, Glen Cove, NY USA) is useful to aid intubation in the ferret and other similarly sized carnivores.

tip supported with a stylette. Many practitioners report topical application of lidocaine to the glottis as being helpful for prevention of laryngospasm when passing the endotracheal tube into the proximal aspect of the trachea. A commercial mouth gag has been produced for the ferret, based on a model of the ferret jaw and dentition (Fig 2). The ferret mouth gag allows a single operator to perform intubation and can be helpful in other species that have similar oral and respiratory anatomy.

In some exotic mammal species, direct visualization of the glottis is enhanced by use of laryngoscope with an appropriately-sized blade. This intubation technique is described most commonly for rabbit patients. It is important for the veterinarian to understand the relationship between the epiglottis and soft palate when attempting intubation of any kind in rabbits and other obligate nasal breathers. The normal position of the epiglottis is above the aboral margin of the soft palate (Figs 3 and 4, *A*). Therefore, the epiglottis must be displaced ventrally, below the soft palate to perform orotracheal intubation.[1,2] Ventral displacement of the epiglottis is accomplished through gentle pressure on this structure and extension of the head (Figs 3 and 4, *B*). It must be kept in mind that applying pressure alone will not facilitate displacement of the epiglottis and dramatically increases the risk of epiglottal damage and edema. The following intubation technique has been found useful for rabbit patients:

1) An assistant holds the mouth of the rabbit open with gauze stirrups looped around the mandibular and maxillary incisors and extends the head and neck forward toward the operator.

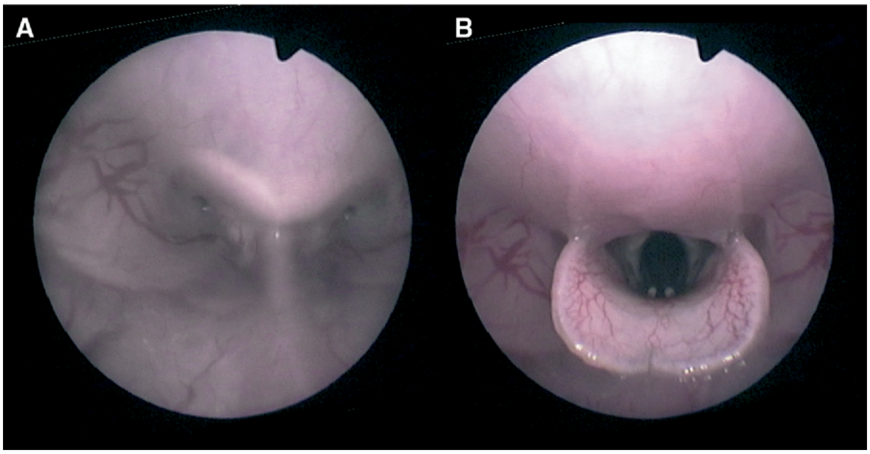

Figure 4. Endoscopic view of the epiglottis and glottis of a rabbit. In (*A*), the epiglottis is in a normal position engaged above the soft palate, a common feature of all obligate nasal-breathing species. In (*B*), the epiglottis is disengaged below the soft palate, allowing introduction of the endotracheal tube.

2) The operator uses a Miller 0 laryngoscope blade, entering the mouth with the laryngoscope blade perpendicular to the palate.

3) The blade is extended gently to the back of the tongue, and then the tongue is depressed ventrally. If the epiglottis is not positioned above the soft palate, the glottis will be visible.

4) If the epiglottis is in position above the soft palate, it will be visible through the thin, soft palate. Gentle pressure with the tube on the soft palate will cause the epiglottis to flip down, revealing the glottis.

5) Instill 0.05 mL of lidocaine into the glottis and wait a few minutes before resuming the position and slipping a 2.0- to 3.5-mm tube with a blunt stylette bent into a 30° angle into the glottis.[3]

A similar technique using a small laryngoscope or an operating microscope has been reported in guinea pigs in the laboratory animal setting and by private practitioners (Johnson-Delaney, personal communication, January 2008).[4,5] Medical supply manufacturers produce expensive intubation kits (Parkland Scientific, Coral Springs, FL USA), which require significant experience to properly insert; this includes a positioning rack, light source, and specially designed laryngoscope. They are advertised for smaller rodent use.

Orotracheal Intubation—Indirect Visualization of the Glottis

Indirect oral intubation is best accomplished with an endoscope, when used side by side with the endotracheal tube, or within the endotracheal tube itself (e.g., over-the-endoscope technique).[6] This technique is most useful in species where direct visualization of the glottis is difficult. Practitioners may use a variety of endoscopes to directly visualize the glottis, including 1.9- to 2.7-mm rigid and/or 2.5 mm or small semiflexible to flexible endoscopes. Great care must be taken when using rigid endoscopes to prevent the application of bending forces, which can damage or destroy the expensive fragile endoscope. For this reason, semiflexible or flexible endoscopes provide a distinct advantage for this intubation technique. Endoscopic-guided intubation of smaller patients is performed directly through visualization of the glottis and manipulation of an endotracheal tube with an inserted stylette into the trachea (Fig 5). Using the over-the-top technique, the endoscope is inserted directly into the lumen of the endotracheal tube as the glottis is visualized and entered. Once the tube enters the tracheal lumen, the tube is slipped off the endoscope, which is then withdrawn (Fig 6).[6,7]

Orotracheal Intubation—Without Visualization of the Glottis ("Blind" Technique)

Blind intubation has been described in the rabbit, and in other larger less common herbivores such as the cavy.[2,8] The authors have not been successful in applying this technique to other exotic mammal species. To perform the blind intubation technique, the rabbit is placed in sternal recumbency and the head grasped and hyperextended so that the proximal trachea is vertically positioned (perpendicular

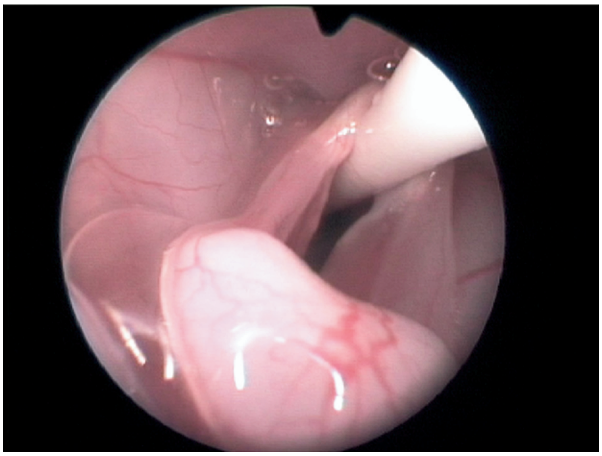

Figure 5. Endoscope-guided intubation of a chinchilla with a 1.5-mm endotracheal tube side by side with a 2.7-mm rigid endoscope.

to the table). The tracheal tube is inserted into the mouth on either side of the incisors and advanced. As described above for laryngoscope-guided intubation, the epiglottis may be positioned above the soft palate, preventing entrance into the trachea. Once the tube advances and touches the epiglottis, it should disengage from the soft palate. The point in which the tip of the tracheal tube is closest to the glottis can be demonstrated in 2 ways:

1) By listening through the open end of the tube for the point of the loudest sound of air movement.
2) By watching for condensation inside a clear endotracheal tube; inspiration is indicated by the disappearance of condensation.

The authors prefer the listening technique and find it far more accurate at determining endotracheal tube placement in rabbit patients. Very careful gentle rotation and back-and-forth movement of the tube will eventually allow entrance into the glottis. With the exception of the most deeply anesthetized rabbits, successful intubation usually produces a cough reflex. It should be noted that significant injury and even death due to glottal edema have been associated with blind intubation in rabbits. In the authors' experiences, injury is extremely rare with blind intubation techniques and is likely associated with the use of force when attempting to guide the tube into the glottis.

Optimal tube size is obviously best judged via direct or indirect visualization techniques. The problem of inadequate tube size can be avoided with the blind technique by opting for sizes based on common selections when using visualization techniques (e.g., for most rabbit cases, 2.5- 3.0 mm). When using a tube that is technically too small, it is easier to blindly intubate a rabbit. Larger, more appropriately sized endotracheal tubes can easily be passed in rabbits with practice. A practice tip to help select optimal endotracheal tube size is to view the particular patient's trachea radiographically, comparing size with the diameter of available endotracheal tubes.

Figure 6. Endoscope-guided intubation using the over-the-top technique. The endoscope is introduced into the lumen of the endotracheal tube, which is guided directly into the trachea. The endotracheal tube is advanced and the endoscope removed. From *Exotic DVM*, with permission.

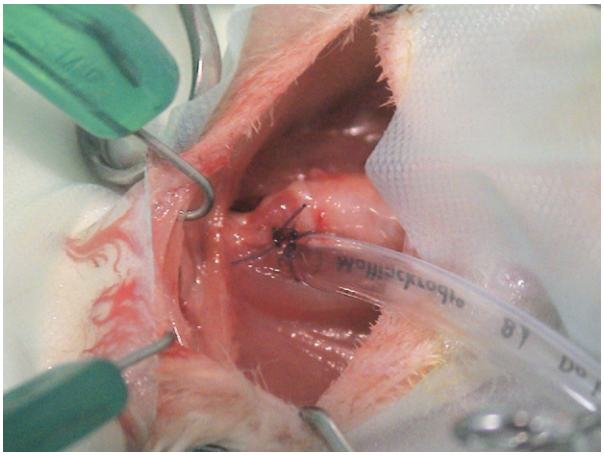

Figure 7. Tracheotomy for placement of an endotracheal tube in a rabbit. The skin and muscle are incised and retracted, revealing the trachea. Note positioning of the 2.5-mm endotracheal tube.

Nasotracheal Intubation

Nasotracheal intubation involves the introduction of a canula into the nasal cavity through the ventral meatus to the level of the oropharynx and into the trachea. By necessity, a tube that is able to pass through the nasal cavity will be significantly smaller than the diameter of the trachea, which will require higher anesthetic gas concentrations and increased production of waste gas. This technique is only feasible in larger exotic mammal species (e.g., rabbits).

Direct Tracheal Intubation (Tracheostomy)

Direct tracheal intubation is performed primarily as an emergency airway support technique. However, other applications include patients that require inhalant anesthesia and airway support in which direct intubation is difficult due to anatomic reasons, or for concerns related to surgical access (e.g., extensive surgery of the oral cavity). The direct tracheal intubation technique is similar to that described in dogs and cats, and the tube selection is based on patient size. The patient is placed in dorsal recumbency and the area from the larynx to thoracic inlet clipped and aseptically prepared. A longitudinal skin incision is made over the intubation site, and subcutaneous tissue and fat bluntly dissected. The sternohyoideus muscle is dissected and retracted laterally to expose the trachea. Once the trachea is isolated, a transverse incision is made between the tracheal rings large enough to accommodate an appropriately sized sterile endotracheal tube, not to exceed 50% of the tracheal circumference (Figs 7 and 8). Stay sutures are placed above and below the incision to facilitate handling of the trachea during tube placement. Once inserted into the trachea, the tube can be secured to the patient by suturing it to adjacent skin. After removal of the endotracheal tube, the tracheal incision is closed with fine monofilament suture (e.g., 5–0 to 7–0 polydioxanone sutures) with 1 to 3 simple sutures encompassing the adjacent tracheal rings; the subcutaneous tissue and skin are closed in a routine manner.[9,10]

Nasal Intubation—Via Nasal Opening

Nasal intubation can be performed in patients that are obligate nasal breathers. However, it should be noted that this technique cannot be considered equal to direct tracheal intubation, and higher concentrations of anesthetic gas are required to maintain anesthetic plane. A single nasal tube allows intake of room air through the contralateral nostril. This can be partially overcome by placement of bilateral nasal tubes, and selection of tube size large enough to reduce intake of room air around the tubes. Nasal intubation is performed by introducing a nasal catheter into the ventral nasal meatus (Fig 9).[11]

Nasal Intubation—Via Rhinotomy/Rhinostomy

In rare cases, delivery of oxygen and anesthetic gases can be accomplished via rhinotomy and direct dorsal access to the nasal cavity. This is most appropriate in cases of complete nasal obstruction in obligate nasal-breathing species, where direct tracheal intubation is not desired. Nasal intubation via rhinotomy/rhinostomy has been described in prairie dogs with odontomas.[12] This intubation technique requires an accu-

Figure 8. Same patient as in Figure 7 with the tracheotomy tube sutured in position as part of preparation for hemimandibulectomy. The tube can be maintained in place after recovery if indicated.

Figure 9. Guinea pig positioned on a tabletop mouth gag in preparation for dentistry. In this case, delivery of anesthetic gas and oxygen is facilitated by a single nasal cannula.

rate understanding of the relationship between the nasal bones and nasal cavity, and the lesion in question.

Complications of Intubation

Complications have been reported with all techniques of intubation in small exotic mammals. The most common complications have been described with oral endotracheal intubation, likely because this technique is practiced most commonly in both the pet and laboratory setting. Complications of endotracheal intubation include inadvertent esophageal intubation and subsequent gastric dilation, glottal trauma and edema, damage to tracheal mucosa, and iatrogenic introduction of food and debris into the airway.[13] Other complications are related to improper tube length. Tracheal tubes that are too long may inadvertently enter a single bronchus, resulting in ventilation/drug delivery to a single lung. Endotracheal tubes smaller than 2.5 mm are used on exotic mammal patients anecdotally associated with a higher rate of obstruction from mucus or a blood clot. All endotracheal tubes are susceptible to obstruction from food and debris during the intubation process.

Complications of nasal intubation include hemorrhage, edema, and infection. Tracheostomy carries additional risks naturally associated with a procedure of this type, including hemorrhage, complete tracheal resection, infection, and dehiscence of the surgical site after repair.

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