Video Article

Endotracheal Intubation of Rabbits Using a Polypropylene Guide Catheter

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Abstract

Endotracheal intubation in rabbits can be challenging due to their unusual anatomy. Achieving a patent airway during anesthesia is critical for the avoidance of airway obstruction, prevention of gastric tympany, and to allow ventilatory support. Due to the difficulty of intubation, alternative methods such as the use of laryngeal mask airways or laryngeal tubes have been explored. However, these methods do not result in direct access to the trachea and thus may present a risk for development of complications. In addition, lack of direct intubation of the trachea can result in personnel exposure to waste anesthetic gases. Numerous methods for endotracheal intubation have been described, including blind placement, use of a fiberoptic laryngoscope or endoscope, and cricoid placement. Despite these numerous publications, many still struggle to achieve success. Here we provide a detailed description of an intubation technique that can be taught with minimal training with a short time to proficiency. Briefly, after administration of injectable anesthesia and proper positioning of the rabbit, a polypropylene catheter is placed into the trachea by direct visualization using a laryngoscope. The catheter is then used as a guide to direct the endotracheal tube into the trachea. This method allows for intubation without the need for expensive equipment and can be performed by a single individual without the need for an assistant. In conclusion, this technique can be easily taught and performed at very little cost in any clinical or research setting.

Video Link

The video component of this article can be found at https://www.jove.com/video/56369/

Introduction

Rabbits have a narrow, deep oral cavity that restricts visibility of the larynx for endotracheal intubation. They also have a very large fleshy tongue and cheek teeth which, when combined with the narrow oral cavity, can cause issues when inserting a laryngoscope and visualizing the glottis to insert an endotracheal tube[1]. Great care must be taken to avoid causing injury to the oral cavity and airway when attempting intubation. The laryngeal tissues are very friable and excessive trauma from repeated attempts to intubate can cause significant inflammation, making intubation more difficult[2].

For these reasons, a variety of alternative techniques have been described, most notably supraglottic airway devices including the laryngeal tube[3,4], the laryngeal mask airway (LMA)[4,5,6] and a species-specific supraglottic airway device[7]. A laryngeal tube consists of a tube with two balloons that direct air flow into the trachea: a larger balloon in the middle of the tube forms a seal in the upper pharynx and a smaller balloon at the distal end seals the esophageal inlet[3]. The LMA consists of a tube with an elliptical mask at the distal end that is inflated to form an airtight seal over the glottis[4,5,6]. The species-specific device is the first veterinary species-specific supraglottic airway device, currently available for cats and rabbits, designed to fit the anatomical structures for each species to create a pressure seal in the pharynx[7]. However, because these devices do not directly enter the trachea, they may present risks for complications such as gastric tympany. The lack of a proper seal within the trachea presents a concern regarding the adequacy for use of these devices for positive pressure ventilation for respiratory support, emergencies, or thoracic surgery[3,8]. In addition, lack of direct intubation of the trachea may result in personnel exposure to waste anesthetic gases[5].

Many methods for direct endotracheal intubation have been described[9,10,11,12,13,14,15]. One popular method is the blind technique, which may decrease the chance of injury to the oropharyngeal cavity since insertion of a laryngoscope isn't necessary[16,17,18,19,20]. As a visually blind technique, this method requires monitoring for air flow through the endotracheal tube and careful manipulation to guide placement. Although this method is commonly used in research and clinical veterinary practice, in the authors' experience, this technique can be time consuming and not always successful, and thus is more difficult to teach and may require extra dosing of anesthetic agents[9,10]. In addition, because monitoring for respiration is used to guide proper placement of the tube, this method would be more difficult and less reliable during respiratory arrest. Another popular method is to use a traditional laryngoscope technique to intubate as is done with larger species. However, the traditional laryngoscope technique in rabbits is difficult in that the view of the vocal cords is obstructed when the endotracheal tube is inserted into the mouth. Therefore, use of this method can result in repeated intubation attempts, increased anesthetic dosing, and injury to the oral cavity and airway[10].

More expensive and technically challenging options for intubation also exist. The fiberoptic laryngoscope allows easy insertion of the endotracheal tube by inserting the laryngoscope into the tube and visualizing the insertion into the trachea on a screen. Similarly, endoscopes can be used to visualize the laryngeal area and guide placement of the tube. However, both of these methods require the use of expensive

equipment that may not be readily available in typical clinical settings[9,11,12]. Intubation via the nasal cavity is an alternative method that has been described, though this presents a risk of introducing opportunistic pathogens from the nasal cavity into the lungs, particularly in rabbits that are not specific-pathogen-free[21]. Lastly, more invasive methods of intubation have also been published, including retrograde insertion of a guide catheter through a needle placed percutaneously into the trachea, as well as the use of a needle cricothyroidotomy followed by placement of a guide wire, vessel dilator, and sheath introducer[13,14]. As invasive techniques, these methods have potential complications such as post-procedural pain and infection. The technique we describe here, using a laryngoscope and guide catheter, can be taught with minimal training with a short time to proficiency, is non-invasive, can be performed by a single individual without the need for an assistant, and does not require the use of specialized equipment.

Protocol

The intubation procedure outlined below was approved by the Mayo Clinic Institutional Animal Care and Use Committee.

1. Preparation (Figure 1)

1. Obtain a 5 French polypropylene catheter and cut the non-rounded end so the total length is 8-10 inches. Mark the cut end of the tubing to clearly indicate which end should **not** be inserted into the trachea (arrow, **Figure 1**).
2. Place a size 0 or 1 Miller laryngoscope blade on the laryngoscope and verify that the light is functioning.
3. Draw 0.25 mL of 2% lidocaine into a 1 mL syringe.
4. Apply sterile lubricant to the end of an appropriately sized uncuffed endotracheal tube (typically 2.5-4.0 mm ID).
5. Prepare supplies for securing the endotracheal tube in place once it is inserted (*e.g.,* umbilical tape).
6. Obtain a device to detect air flow at the end of the procedure to confirm successful intubation (**#5, Figure 1**). This is Optional.

2. Anesthesia

1. Administer injectable anesthesia, such as 35 mg/kg ketamine and 5 mg/kg xylazine intramuscularly using a 3 mL syringe with a 25 gauge needle in the quadriceps muscle of the hind leg of an approximately 4 month old, 3.0-3.5 kg, New Zealand White rabbit.
   NOTE: This anesthetic regimen is a commonly used injectable combination in young, healthy, specific pathogen-free research rabbits, but based upon clinical condition and/or experimental objectives, a different protocol may be more appropriate.
2. After the rabbit is anesthetized, apply sterile ophthalmic lubricant to the eyes to preserve the corneal tissue.

3. Endotracheal Intubation

1. Measure the endotracheal tube from the incisors to the thoracic inlet to determine the proper length for insertion of the endotracheal tube. Placement of the end of the tube at the level of the thoracic inlet assures that the tube opening is past the larynx but cranial to the tracheal bifurcation.
2. Position the rabbit sternally on the preparation table with its head slightly extended over the edge of the table (**Figure 2**). The rabbit should be positioned square with the head and spine in straight alignment.
3. Lifting the head up, use a gauze pad to pull the rabbit's tongue lateral to the rabbit's right lower incisors (in the diastema), taking care to avoid trauma from the incisors.
4. Grasp the laryngoscope and blade with the right hand and place it into the mouth behind the incisors, entering from the rabbit's left.
5. Follow the roof of the mouth with the tip of the blade in a caudal direction until the soft palate is visible.
6. With the right hand, tip the laryngoscope forward (bend the wrist, holding the laryngoscope downward) while extending the rabbit's head back and the neck forward to maintain an open airway and view the larynx (**Figure 3A**). As obligate nasal breathers, the epiglottis is often above the soft palate, and use of this method compresses the base of the tongue to displace the epiglottis and expose the glottis. To prevent oxygen desaturation, it is important to keep the neck extended as described to maintain an open airway during intubation.
7. Release the tongue and switch the laryngoscope blade to the left hand to free up the right hand for placement of the guide catheter.
8. While holding the laryngoscope and maintaining view of the glottis (**Figure 3B**), advance the rounded tip of the guide catheter through the opening past the larynx (**Figure 4**). The catheter will come to a natural stop at the tracheal bifurcation.
9. While maintaining hold of the guide catheter, grasp the endotracheal tube and thread it over the catheter, taking care not to apply force to the catheter by catching it on the endotracheal tube connector. Advance the tube until there is resistance from the vocal cords (**Figure 5**).
10. Instill 0.25 mL of 2% lidocaine into the opening of the endotracheal tube. The lidocaine will travel down the endotracheal tube to locally anesthetize the vocal cords, preventing laryngospasm[22] (**Figure 6**).
11. Allow approximately two minutes for the topical anesthesia to take effect, and proceed by gently twisting the endotracheal tube, advancing it through the vocal cords (**Figure 7**). Once the tube has passed the vocal chords, remove the laryngoscope blade and catheter, taking care not to dislodge the tube.
12. Verify placement of the endotracheal tube by observing airflow. There are multiple ways to accomplish this, including placement of a tissue or fur at the end of the tube to detect airflow, looking for fogging of the tube or fogging of a glass/mirror at the end of the tube, and listening for airflow. Devices designed to detect airflow[23] or respirations may also be used (**Figure 8**) to determine whether intubation was successful (see **Materials Table** for options). Secure the endotracheal tube using a preferred method, such as umbilical tape tied around the tube and head. Attach the anesthesia circuit and auscult both sides of the thorax while giving breaths to assure ventilation to both sides of the lung.

Representative Results

At the authors' institution, this technique is typically taught to laboratory and veterinary personnel during training sessions on rabbit handling and anesthesia techniques. Teaching sessions are performed with dedicated training animals. The trainer demonstrates the technique once and then trainees perform the technique under the guidance of the trainer. Trainees typically achieve success within 1-3 attempts. After they have successfully intubated the rabbit once, individuals are required to perform the intubation a second time, and are typically able to successfully intubate the rabbit again on the first additional attempt. Feedback during these training sessions, particularly from individuals who have been previously trained with alternative techniques, consistently includes comments on how easy this technique is to learn and complete successfully.

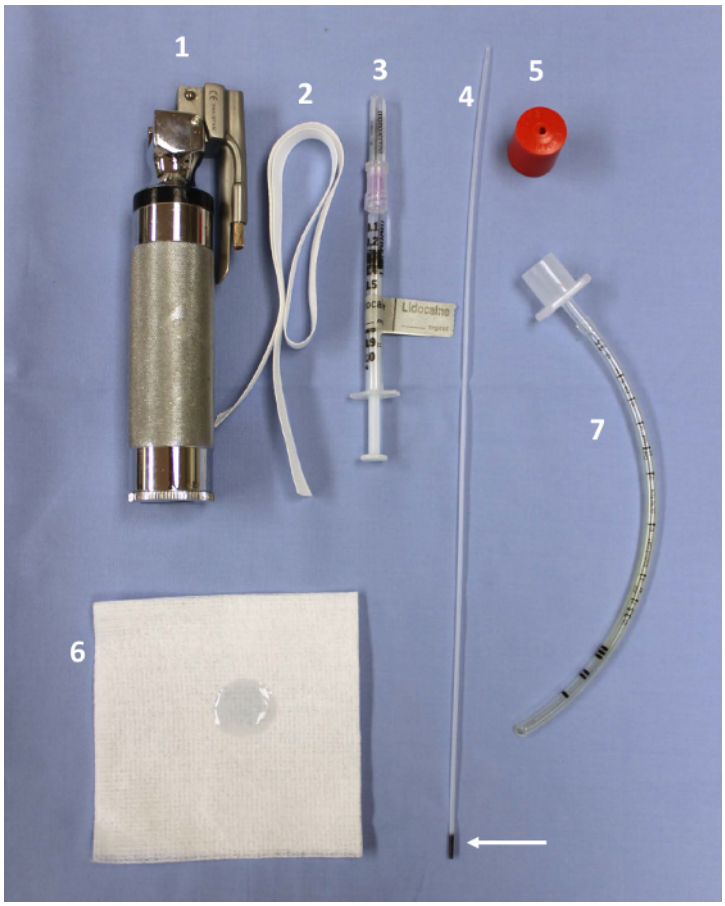

Figure 1. **Supplies for endotracheal intubation:** 1) Laryngoscope with size 0 or 1 Miller laryngoscope blade, 2) umbilical tape (or other supplies for securing endotracheal tube), 3) 0.25 mL of 2% lidocaine, 4) 5-French polypropylene catheter cut to 8-10 inches with the non-rounded end marked with a permanent marker to clearly indicate which end should not be inserted into the trachea (arrow), 5) air flow detection device, 6) sterile lubricant to be applied to the distal end of the tube, 7) uncuffed endotracheal tube. Please click here to view a larger version of this figure.

Figure 2: Sternal positioning for endotracheal intubation. The rabbit is positioned sternally with the forelimbs extended to the end of the table. The hind limbs are extended back, and the rabbit's head is aligned with the spine. The left hand is used to elevate the head into extension in preparation for insertion of the laryngoscope. Please click here to view a larger version of this figure.

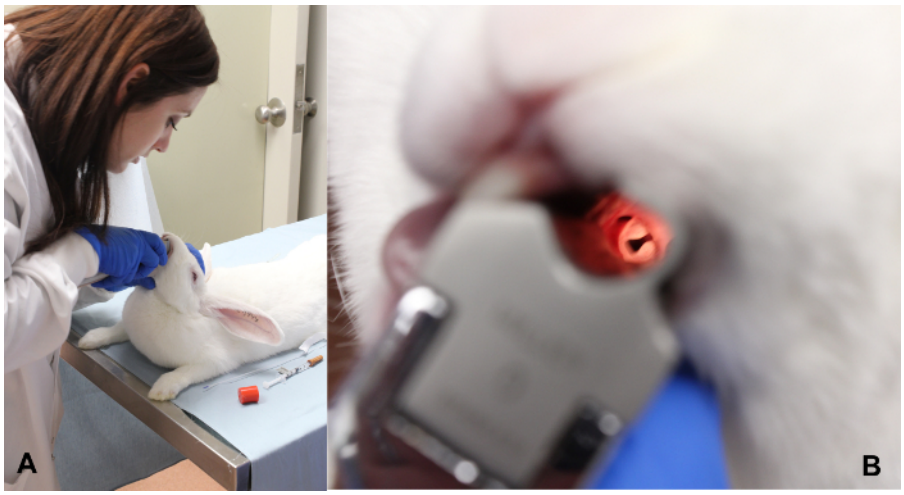

Figure 3: Insertion of laryngoscope. A) The laryngoscope is inserted into the left diastema using the right hand, following the roof of the mouth with the tip of the blade until the soft palate is visible. Once the soft palate is visible, the laryngoscope is tipped forward while extending the rabbit's head back and neck forward to visualize the larynx. B) Visualization of the larynx. Please click here to view a larger version of this figure.

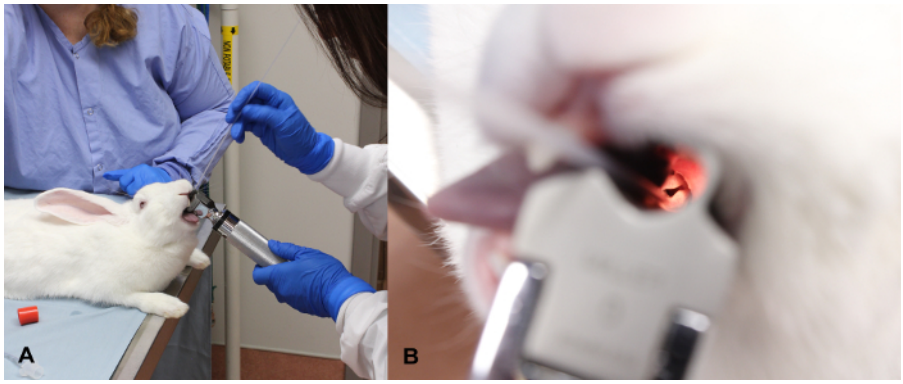

Figure 4: Advancement of the guide catheter. A) After switching the laryngoscope blade to the left hand, the right hand advances the rounded tip of the guide catheter through the opening past the larynx. B) The guide catheter is passed through the vocal chords with direct visualization. Please click here to view a larger version of this figure.

Figure 5: Advancement of the tracheal tube. The endotracheal tube is threaded over the guide catheter and is advanced until there is resistance from the vocal cords. Please click here to view a larger version of this figure.

Figure 6: lidocaine instillation. Lidocaine (2%, 0.25 mL) is instilled into the opening of the endotracheal tube. Please click here to view a larger version of this figure.

Figure 7: Endotracheal tube advancement. Two minutes after instillation of the lidocaine, the endotracheal tube is advanced by gently twisting it to pass through the vocal cords. Please click here to view a larger version of this figure.

Figure 8: Verification of air flow through the endotracheal tube. An airflow detection device may be used to verify air flow through the endotracheal tube, or a dental mirror may also be used to detect the condensation from breaths indicating successful intubation. Please click here to view a larger version of this figure.

Discussion

Here we provide a detailed description of a rabbit intubation technique that can be easily mastered in any clinical setting. This technique is similar to previously published direct visualization techniques[10,15,20,25] with some additional refinements, including use of a 3.5 mm uncuffed endotracheal tube, and a 5 French urinary catheter as our chosen guide, which has been cut and marked with a permanent marker at the cut end. The rabbit trachea is easily prone to injury and thus the use of uncuffed endotracheal tubes is generally recommended when intubating rabbits to prevent damage to the tracheal mucosa from the pressure of the cuff.[26] The 5 French urinary catheter we chose as a guide is small

enough to easily pass through the vocal folds without obstructing the view during direct visualization of the larynx. While small, this catheter is stiff enough to remain in place as a guide for the endotracheal tube. The distal tip of the catheter is rounded to help reduce trauma when the bifurcation is reached. The proximal end of the catheter is cut so that the catheter is at a workable length (not excessively long) and to remove the end that widens for attachment to a syringe. The cut end is marked with permanent marker as a visual indicator to not insert this end into the trachea, which may cause damage to the tracheal mucosa.

The primary limitation of this technique is that, because it does require the use of a laryngoscope blade, it may not be feasible for very young rabbits or very small breeds due to smaller mouth size. In addition, some facilities may not have this size of laryngoscope blade readily available. At the author's institution, this method is used for New Zealand White (≥6 weeks) and adult Dutch Belted rabbits, but we have not attempted this method in younger animals or smaller breeds. In situations where the rabbit patient is small, or if a laryngoscope with a small Miller blade is unavailable, an alternative option is to use a handheld otoscope rather than the laryngoscope.[15,20] Using an otoscope with a #5 ear speculum, the larynx is visualized, the guide catheter is placed by direct visualization, and the speculum is removed prior to proceeding following the same steps as outlined above.

It is important to use great care when the guide catheter is placed to avoid the possibility of causing trauma or bronchospasm as the end of the catheter passes into the trachea and touches the tracheal bifurcation. The risk of these complications can be reduced or avoided by feeding the catheter with very gentle movements, stopping as soon as there is resistance, and avoiding movement of the head and neck once the catheter is in place. In addition, when advancing the endotracheal tube over the catheter, there is the potential for the catheter to catch on the endotracheal tube connector. Thus, it is important to make sure that the catheter slides through the connector without catching; alternatively, the connector can be removed and replaced when securing the endotracheal tube or attaching to the anesthetic circuit.

With any method of intubation, there is the potential for complications and adverse effects. Using the direct visualization method with a laryngoscope, improper insertion of the laryngoscope blade or aggressive placement of the endotracheal tube can result in laryngeal, tongue, or tooth injuries. Correct positioning of the animal is the first critical step in minimizing trauma during visualization of the larynx. The spine should be straight, with the head in direct alignment with the spine; if the animal is not straight, or if the neck is twisted to the left or right, this will make visualization of the larynx more difficult and may result in excessive trauma with the laryngoscope blade. Another critical key to success when using this technique is to follow the roof of the mouth towards the larynx, and once the soft palate is visualized, shift the blade into a proper position by bending at the wrist. This keeps the head in place, while moving the tip of the blade into optimal viewing position of the vocal cords, which are located quite ventral in the rabbit[20,24].

Because direct visualization of the larynx can be tricky if the precise techniques we outline above are not followed, the use of alternative intubation strategies that do not require visualization of the larynx can be appealing. For example, the blind technique is one possible option that does not require use of a laryngoscope[16,17,18,19,20]. However, use of this technique relies on the ability to detect airflow through the endotracheal tube in order to direct the placement of the tube, and if the animal's breaths are very shallow or arrested, use of this method is not reliable. Supraglottic devices may also be considered, since placement of these devices does not require visualization of the larynx and they are generally very easy to place. These devices do not directly enter the trachea, however, and thus there is potential for lack of direct flow to the airway, inability to ventilate if laryngospasm develops, lack of a seal tight enough for ventilation during open-chest procedures or emergency resuscitation, and development of gastric tympany[3,4,8]. Newer devices specifically designed for rabbits may offer a promising alternative, but more studies are needed to evaluate these devices, and the concerns regarding lack of entry into the trachea still remain. Gastric tympany can also be a potential complication in an intubated animal if the endotracheal tube is accidentally placed into the esophagus; however, use of a direct visualization technique minimizes the risk of this complication by verifying proper placement of the guide catheter into the larynx.

Trauma to the arytenoid and/or tracheal mucosa is another potential concern when inserting an endotracheal tube, particularly when using inflatable cuffed tubes[26,27,28]. The trachea in rabbits may be easily injured, which can lead to complications such as subcutaneous emphysema, pneumothorax, and even death[10,27,28,29]. While performing the technique we describe here, care should be taken to prevent tracheal injury by use of uncuffed endotracheal tubes, ensuring the rounded tip of the guide catheter is inserted into the trachea, and not forcing the guide catheter into the glottis. In addition, selection of an appropriately sized endotracheal tube is of critical importance. Endotracheal tube size should be considered against the size of the animal, as well as compared to the opening of the laryngeal inlet since it is smaller in diameter than the trachea. An endotracheal tube too large in diameter may result in trauma to the arytenoid mucosa or cartilage. On the other hand, use of a smaller endotracheal tube results in increased airway resistance and increases the chances of obstruction due to mucus or a kink. For this reason, respiratory monitoring is very important in intubated rabbits. In addition to pulse oximetry, measurement of airflow should be monitored with capnography; if a capnograph is unavailable, airway monitors are an alternative that can be used to detect flow of air (but do not provide measurements of exhaled carbon dioxide). In addition, provision of assisted ventilation can be valuable, particularly in cases when smaller diameter tubes are used[24,30].

In addition to the already mentioned benefits of using this technique, another major advantage of this method is that it can be performed by a single individual without the need for an assistant, which can be important in a busy clinical setting. In this situation, it is important to gather all necessary supplies and have them within easy reach during the intubation process, particularly when the guide catheter is in place and movement of the head should be avoided.

The technique we describe here is used by the veterinary and research staff in our institution for all rabbit intubations, which amounts to approximately 200-400 intubations per year. It is very easily taught in a typical rabbit anesthesia training session, which takes approximately 30 minutes. We have found that it is relatively easy to learn, with students learning it within their first 3 attempts and generally able to repeat the process successfully in the next additional attempt.For future study, it would be valuable to compare time to proficiency and ability to maintain proficiency over time for this method compared to other intubation techniques. While this has been studied for variations of blind techniques[16], a comprehensive assessment of the learning curve for a wide variety of intubation techniques has not yet been performed. Another potential future direction of study could include comparing direct endotracheal intubation to the newer species-specific supraglottic airway devices, particularly concerning function during positive pressure ventilation.

In conclusion, the technique for intubation of rabbits we describe here is non-invasive, reliable, does not require the use of specialized equipment, is easy to master, and can be performed by a single individual without the need for an assistant. All airway access techniques

present some level of risk, but by using a direct visualization technique and following the steps we describe above to minimize complications, the risks are far outweighed by the benefits of having an adequate airway during anesthesia.

Disclosures

The authors have nothing to disclose.

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