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Case Report- Veterinary Medicine



# Anatomical study of the upper airways and description of the technique used for tracheal intubation in guinea pigs (*Cavia porcellus*): a case series study

[*Estudo anatômico das vias aéreas superiores e descrição da técnica utilizada para intubação traqueal de porquinhos-da-índia (*Cavia porcellus*) – estudo de uma série de casos*]

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## ABSTRACT

The objective of this study is to describe the technique used for orotracheal intubation in six guinea pigs under general anesthesia and previously chemically restrained. For orotracheal intubation of all animals, an ear wax cleaner with LED light was used as an adapted laryngoscope, and intubation was performed with a 2 mm inner diameter tube without a cuff. Capnography ensured the correct positioning of the tube in all animals, and none of them presented any complications resulting from intubation or after extubating. Intubation is essential, since there is respiratory depression from the use of anesthetics employed in this species. Other auxiliary equipment has already been used successfully for airway access in this species, but the techniques are still underutilized. The positioning of the animals and the use of the light device made it possible to intubate the animals safely and easily.

Keywords: Guinea pig, airways, rodent, anesthesia

## RESUMO

*O objetivo deste trabalho é descrever a técnica utilizada para intubação orotraqueal em seis porquinhos-da-índia submetidos a anestesia geral, e previamente contidos quimicamente. Para a intubação orotraqueal de todos os animais foi utilizado um limpador de cera de ouvido com luz de led como laringoscópio adaptado, e a intubação foi realizada com tubo de dois milímetros de diâmetro interno sem balonete. A capnografia assegurou o posicionamento correto do tubo em todos os animais e nenhum deles apresentou qualquer complicação decorrente da intubação ou após a extubação. A intubação se mostra fundamental, uma vez que há depressão respiratória a partir do uso de anestésicos empregados nesta espécie. Outros equipamentos auxiliadores já foram utilizados com sucesso para o acesso das vias aéreas nesta espécie, porém as técnicas ainda são subempregadas. O posicionamento dos animais e o uso do dispositivo luminoso viabilizaram a técnica de intubação dos animais em questão de forma segura e facilitada.*

*Palavras-chave: cobaia, vias aéreas, roedor, anestesia*

## INTRODUCTION

Guinea pig anesthesia is challenging due to anatomical factors, such as gastrointestinal particularities, oral cavity structure, airway morphology, and small body size, which limits anesthetic monitoring. Behavioral aspects, such as a high level of stress, also contribute to the complexity (Hawkins and Graham, 2007).

In anesthetic practice across various species, tracheal intubation is routinely performed, and direct visualization of the larynx is the most commonly used technique However, airway management in guinea pigs remains a challenge: they have a small and narrow oral cavity, reduced tracheal diameter, a thick and elongated tongue, and a fusion between the soft palate and the base of the tongue, in addition to producing

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an abundant amount of salivary secretion. The soft palate features a small opening called the palatal ostium, which provides access to the larynx. The larynx is located dorsally within the oropharynx and is closely associated with the nasopharynx, making guinea pigs obligate nasal breathers. These factors make tracheal intubation difficult, often leading to the use of face masks during anesthesia (Hawkins and Graham, 2007).

Since the pioneering study by Kujime and Natelson (1981), several methods for tracheal intubation in guinea pigs have been published with an experimental focus, including the development of animal restraint devices and adapted microscopy and laryngoscopy tools (Costa *et al*., 1986; Kramer *et al*., 1998). Clinical studies also highlight the difficulties and problems associated with intubation and have employed tools such as fiber optic endoscopes in this and other species as aids. Although these devices assist with direct visualization of the larynx, they are costly and require training for proper use (Johnson, 2010). The same study by Johnson (2010) emphasizes that the internal diameter of the tracheal tube used should be the largest possible size to avoid increased airway resistance and that the correct tube size typically corresponds to two-thirds of the tracheal lumen diameter or approximately the size of the laryngeal opening. It is recommended that guinea pigs be intubated with tubes of 2.0 to 2.5 millimeters (mm) in internal diameter, or with an 8 French (Fr) urethral catheter. Although the use of cuffed tracheal tubes is not contraindicated, the cuff often increases the tube's external diameter excessively, making it too large to pass through the larynx (Johnson, 2010).

Refining a simple technique for tracheal intubation in this species is essential for the safe maintenance of the airway, proper oxygenation, and ventilatory support during anesthesia, as well as for optimizing emergency management in these animals.

## ETHICAL ASPECTS

This research was not submitted to the *Ethics Committee on Animal Use*.

## CASE REPORT

This study describes the technique used for orotracheal intubation in six guinea pigs undergoing general anesthesia, utilizing an earwax removal device equipped with an LED light. The device features an illuminated shaft approximately 4cm in length, which enabled direct visualization of the larynx in these animals. No food or water was withheld prior to anesthesia, and all animals received subcutaneous metoclopramide (0.5mg/kg) and oral simethicone (0.5mL) to prevent gastrointestinal disturbances.

The drugs used in the pre-anesthetic medication, the body weight of each animal, and the surgical procedure to which each was subjected are described in Table 1.

Table 1. Pre-anesthesia protocols, body weight, and surgical procedures to which the guinea pigs included in this study were subjected.

| Case | Anesthesia protocol - premedication (IM) | Kg | Procedure |
|---|---|---|---|
| 1 | Ketamine 8mg/kg, midazolam 1mg/kg, tramadol 5mg/kg | 0.700 | Tooth wear |
| 2 | Ketamine 8mg/kg, midazolam 1mg/kg, morphine 1mg/kg | 0.500 | Enucleation |
| 3 | Ketamine 8mg/kg, midazolam 1mg/kg | 0.950 | Skyn biopsy |
| 4 | Ketamine 8mg/kg, midazolam 1mg/kg | 0.650 | Cystotomy |
| 5 | Ketamine 6mg/kg, midazolam 1mg/kg | 1.000 | Ear biopsy |
| 6 | Ketamine 10mg/kg, midazolam 1mg/kg | 0.450 | Orchiectomy |

Source: Prepared by the authors (2025).

All animals were pre-treated with ketamine and midazolam administered intramuscularly (IM), and some received an additional opioid. Immediately after the administration of pre-anesthetic medication, all animals received intramuscular atropine sulfate (0.05mg/kg) to reduce salivary secretions (Tokuyama *et al*., 1990). Venous access was established via the cephalic vein using a 24 or 26G intravenous catheter, and anesthetic induction was carried out with isoflurane (2.0 to 2.5%) diluted in 2L/min of 100% oxygen, delivered through a nasal mask adapted from a 20mL syringe.

Once the interdigital pinch and palpebral reflexes were absent, the animals were positioned in ventral recumbency with cervical extension oriented craniodorsally. A cheek retractor was used to aid in the opening of the oral cavity, which was cleansed using cotton swabs, while anesthesia was maintained with the mask (Fig. 1). An earwax cleaner with an LED light was used as an adapted laryngoscope (Figure 2)—a model similar to that used by Rassy (2020) in golden-headed lion tamarins—and after laryngeal visualization, lidocaine (0.5mg/kg) was instilled onto the laryngeal region. Orotracheal intubation was then performed using a 2 mm internal diameter, uncuffed endotracheal tube, which was connected to a non-rebreathing anesthetic circuit.


Source: prepared by the authors (2025).

Figure 1. (A) Guinea pig under anesthetic maintenance with isoflurane via nasal mask positioned for tracheal intubation; (B) Guinea pig under anesthetic maintenance with isoflurane via nasal mask positioned for tracheal intubation, with the use of a cheek retractor along with the adapted laryngoscope positioned for direct visualization of the larynx.

Source: prepared by the authors (2025)

Figure 2. LED ear cleaner used as an adapted laryngoscope.

Uncuffed endotracheal tubes, size 8 Fr, with a 2mm internal diameter and 2.9mm external diameter, and a length of 14.5cm, were used. For animal number 02 (500g body weight), the tube was previously shortened to 10cm to reduce mechanical dead space, and for animal number 06 (450g body weight), it was shortened to 8cm. The cuts were made at the proximal end of the tube, preserving the distal tip suitable for tracheal insertion. The proximal connector, which

attaches the tube to the anesthetic circuit, was reattached after adjusting the length. In all other animals in the study, the full length of the endotracheal tube was maintained.

Capnography confirmed correct tube placement in all animals, and none showed any complications related to intubation or following extubation. Ventilation was assisted whenever necessary. Figures 3, 4, 5, and 6 illustrate all the animals included in this study under general anesthesia and orotracheal intubation.


Source: prepared by the authors (2024).

Figure 3. (A) Guinea pig no. 01 immediately after tracheal intubation, confirmed by mainstream capnography; (B) Guinea pig no. 02 under general anesthesia, positioned in lateral recumbency, with tracheal intubation confirmed by mainstream capnography.


Source: prepared by the authors (2024).

Figure 4. (A) Guinea pig no. 03 under general anesthesia, positioned in lateral recumbency, with tracheal intubation confirmed by sidestream capnography (capnography line connected to the tube using a needle in place of the "T" piece to reduce mechanical dead space); (B) Guinea pig no. 04 under general anesthesia, positioned in dorsal recumbency, with tracheal intubation confirmed by sidestream capnography.

Source: prepared by the authors (2024)

Figure 5. Guinea pig no. 05 under general anesthesia, positioned in ventral recumbency, with tracheal intubation confirmed by sidestream capnography.


Source: prepared by the authors (2024)

Figure 6. (A) Guinea pig no. 06 under general anesthesia, positioned in dorsal recumbency, with tracheal intubation confirmed by sidestream capnography. (B) Image of the shortened endotracheal tube after extubation of guinea pig no. 06.

Although this study does not have an experimental nature, the improvement in performing this technique motivated us to conduct an anatomical study that may contribute to the optimization of the procedures. Two adult guinea pig cadavers were used, which had died at the veterinary hospital due to health problems and were donated for academic study by their owners. The animals weighed 600 grams (g) (animal I) and 500g (animal II). The specimens were photo-documented for anatomical evaluation.

## RESULTS

In the immediate post-mortem examination of animal I, the full opening of the oral cavity was measured, which was approximately 0.85 centimeters (Fig. 7).

After freezing the animals' bodies, a longitudinal cut was made using an electric band saw to expose the head structures, aiming to study the airways.


Source: prepared by the authors (2024).

Figure 7. Measurement of the oral cavity opening in a guinea pig cadaver.

The influence of head positioning on the difficulty of endotracheal tube insertion and the distance traveled between the oral cavity entrance and the laryngeal inlet were evaluated.

It was understood that cervical flexion hindered the path the tube would take to enter the trachea, while cervical extension in the dorsal direction somewhat facilitated tube insertion (Fig. 8–A and B), although the elongated palate still posed a complicating factor. This highlights the importance of using an adapted device such as a laryngoscope, which has a long blade and assists the operator in overcoming this physical barrier.

The distance traveled between the entrance of the oral cavity and the laryngeal inlet measured approximately 3.2cm in both specimens (Fig. 9, A and B). Therefore, the tube should be inserted approximately 3.5cm from the entrance of the oral cavity to the laryngeal inlet.

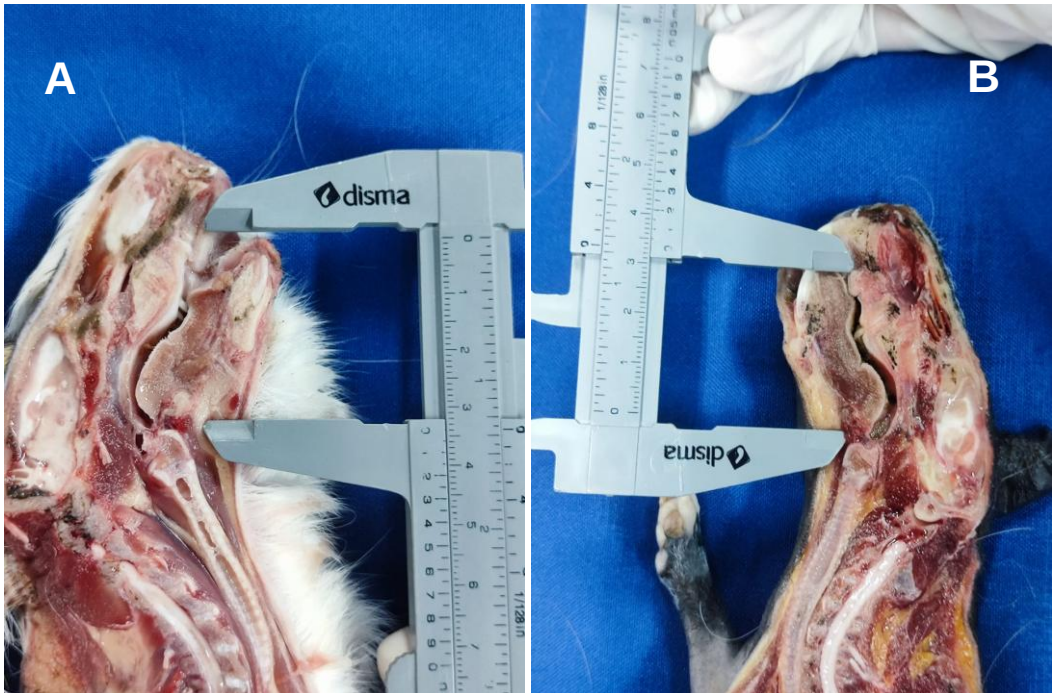
The cervical portion of the trachea that was observable in both specimens measured approximately 4 to 4.5cm in length (Fig. 10, A and B).

Considering that the tube should be inserted 3.5cm from the oral cavity to the entrance of the trachea, and that it would pass through 2 to 4cm of tracheal length, with an external portion of the tube protruding approximately 3 to 4cm (Nambiar *et al*., 2007), the total length of the endotracheal tube for guinea pigs weighing 500 to 600g should measure between 8.5 and 11.5cm.

The external diameter of the trachea in both animals measured approximately 2.5mm (Fig. 11), supporting the use of a 2 mm endotracheal tube for guinea pigs weighing 500 to 600g.

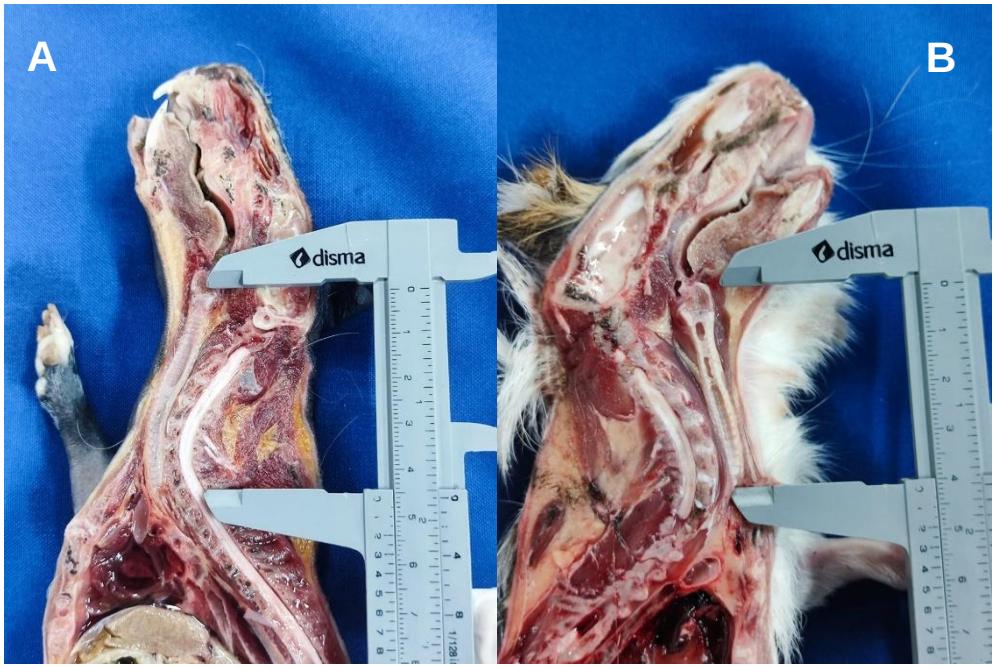
Source: prepared by the authors (2024).

Figure 8. Anatomical specimens of guinea pig hemi-heads and necks, demonstrating the negative impact of cervical flexion (A) on the tracheal intubation technique, and the positive impact of dorsal cervical extension (B) on the tracheal intubation technique.




Source: prepared by the authors (2024)

Figure 9. Anatomical specimens of guinea pig hemi-heads and necks, with measurement in centimeters using a caliper of the distance from the oral cavity entrance to the laryngeal inlet.




Source: prepared by the authors (2024).

Figure 10. Anatomical specimens of guinea pig hemi-heads and necks, with measurement in centimeters of the cervical portion of the trachea demonstrated using a caliper.


Source: prepared by the authors (2024).

Figure 11. Anatomical specimen of a guinea pig hemi-head and neck, showing the external diameter of the most rostral portion of the trachea.

## DISCUSSION

Orotracheal intubation proves to be fundamental during general anesthesia in guinea pigs for increased procedural safety, since significant respiratory function decline occurs with various combinations of anesthetic protocols used in this species (Serighelli Júnior *et al*., 2024; Schwenke and Cragg, 2004; Sixtus *et al*., 2021). Endotracheal intubation is the only truly effective method for providing ventilatory support, as even supraglottic devices have not been developed for this species. Additionally, the cardiovascular impact caused by anesthetic agents can lead to systemic complications and further necessitate ventilatory support (Mooney *et al*., 2012).

Dissociative anesthesia protocols are frequently employed in this species due to the maintenance of protective reflexes and a lower incidence of respiratory depression or apnea. It is important to note that these protocols provide sedation; however, anesthetic depth is inconsistent and they do not supply sufficient analgesic support for more invasive surgical procedures (Rhodes *et al*., 2001).

Some devices to assist with otoscopy, videoscopy, and others have been successfully used previously for endotracheal intubation in these animals (Nambiar *et al*., 2007; Turner *et al*., 1992), but intubation techniques remain underutilized.

Oral cavity cleaning with the animal already anesthetized optimizes endotracheal intubation by reducing the chances of tube obstruction by food content and preventing debris from being carried into the trachea (Lennox and Capello, 2008). Ventral recumbency and dorsal cervical positioning also contribute to the success of the technique, as demonstrated by Johnson (2010) and observed in the present anatomical study.
According to the suggestion by Nambiar *et al*. (2007), the tube should be inserted 6cm from the upper incisors in guinea pigs weighing approximately 300g (3cm from the upper incisors to the larynx, plus another 3 cm of tube inserted into the trachea), with an external protrusion of 4cm from the incisors, totaling a tube length of 10 cm. Based on the present anatomical report, the tube should be inserted approximately 3.5cm from the entrance of the oral cavity to the laryngeal inlet, and would pass through 2 to 4cm of tracheal length, suggesting that the total length of the endotracheal tube for guinea pigs weighing 500 to 600g should be between 8.5 and 11.5cm.

Further studies are needed to consider other variables such as different guinea pig sizes (weight, body score, and total body length), breed, the influence of other anesthetic protocols, and even the use of alternative assisting devices. This report encourages the improvement and utilization of endotracheal intubation in this species, given the advantages of securing an airway compared to the use of face masks during anesthesia, whether in clinical or experimental routines.

## CONCLUSION

The positioning and use of the illuminated device enabled the orotracheal intubation technique in the animals studied, and no complications arose from the use of this technique. The cadaveric anatomical study helped clarify the optimal positioning of the head and cervical region for tracheal intubation, as well as the appropriate lengths of endotracheal tubes that can be used in this species.

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## CONTRIBUTORS

J.R. Moncayo: study conception, objective, methodology, data collection, data analysis, and manuscript writing. A.F.K.T. Lima: methodology and investigation. F.A. Pinheiro: manuscript review and editing. M.C.R. Silva: data collection and manuscript review and editing. S.R.G. Cortopassi: supervision and manuscript review. All authors approved the version to be published.

## DATA AVAILABILITY STATEMENT

The research data are available within the article itself.

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