

Case Report

Anesthetic and Airways Management of a Dog with Severe Tracheal Collapse during Intraluminal Stent Placement

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Received 23 October 2013; Accepted 8 December 2013

Academic Editors: K. K. Adamama-Moraitou and J. S. Munday

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This case report describes the anesthetic and airways management of a dog affected by 4th degree tracheal collapse and undergoing endoscope-guided intraluminal stent placement. After premedication with acepromazine and butorphanol, general anesthesia was induced with propofol and maintained with intravenous propofol and butorphanol in constant rate infusion. During intraluminal stent placement, oxygen was supplemented by means of a simple and inexpensive handmade device, namely, a ureteral catheter inserted into the trachea and connected to an oxygen source, which allowed for the maintenance of airways' patency and adequate patient's oxygenation, without decreasing visibility in the surgical field or interfering with the procedure. The use of the technique described in the present paper was the main determinant of the successful anesthetic management and may be proposed for similar critical cases in which surgical manipulation of the tracheal lumen, which may potentially result in hypoxia by compromising airways patency, is required.

1. Introduction

Tracheal collapse is a progressive condition which mainly affects small-breed dogs, characterized by degeneration of the hyaline cartilage rings and weakening of the dorsal trachealis muscle [1, 2]. Besides conservative medical management, which is reported to palliate clinical symptoms for several years in most cases [3], more invasive treatment options are either surgical application of extraluminal rings [4–8] or endoscope-guided intraluminal stent placement [9–14]. The latter, although considered minimally invasive [7], is the most challenging in terms of anesthetic management, owing to the difficulty of maintaining the airways patent throughout the entire procedure. In order to perform the surgery in a safely intubated patient, the endoscope's distal end may be inserted into the trachea through the endotracheal tube (ETT). However, this technique entails some drawbacks, such as limited visibility of the surgical field and, especially in toy breeds in which only small diameter ETT can be placed, obstruction of the ETT lumen. Thereby, it is generally

preferred to have the trachea not to be intubated during intraluminal stents placement. On the other hand, even in case of nonintubated airways, the endoscope's tube itself may narrow the tracheal lumen enough to compromise oxygenation.

Oxygen supplementation may be provided by means of different methods, although none of them seem to be optimal for surgical procedures involving the tracheal lumen in terms of efficiency, simplicity, and practicability. Jet ventilation, either transtracheal, via percutaneous insertion of a hypodermic needle, or intratracheal via a semiflexible catheter, is regarded as a useful tool capable of providing efficient oxygenation even in case of nonpatent airways; nevertheless, not all facilities have such expensive and sophisticated equipment at their disposal. Flow by technique is simple and inexpensive and may be useful to provide oxygen supplementation in spontaneously breathing patients; however, because the mouth is the entry site of the tracheoscope tube, it may be difficult to position the oxygen source in a useful location without interfering with the surgical procedure.

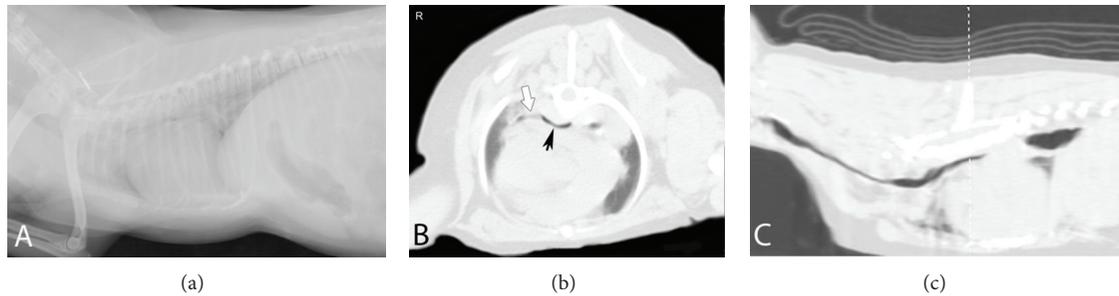


FIGURE 1: Preinterventional radiographic (a) overview of the thorax, left lateral projection. The thoracic volume is small and the caudoventral rib cartilages are pulled inwards. Pulmonary contrast is poor. The tracheal and mainstem bronchial lumen are partly reduced in width and opacified. Computed tomography (CT) was performed 12 h later, transverse view (b) at the level of the bifurcation (reference line) in the sagittal reconstruction (c). The scan performed without intubation is shown here. Severe dorsoventral tracheal flattening (black arrowhead) is present, and the right mainstem bronchus (solid white arrow) is also compressed.

We describe the use of a handmade, inexpensive, and simple device, composed of an oxygen source and a polyurethane ureteral catheter, to provide oxygen supplementation and ensure upper airways' patency in a dog undergoing endoscope-guided intratracheal stent placement. To the best of the authors' knowledge, such a technique has never been described in dogs.

2. Case Presentation

An 11-year-old, 2.8 kg female Yorkshire Terrier was referred to the Veterinary Teaching Hospital of the University of Berne with a history of stridor and respiratory distress no longer responsive to conservative medical treatment. On physical examination, physiological parameters were deemed normal, but stridor and louder inspiratory murmur were detected upon chest auscultation. Except for monocytosis (8%) and slightly elevated blood urea nitrogen (14 mmol/L) and creatine kinase (519 IU), blood biochemistry and hematology were within normal ranges for the species. Thoracic radiographic exam revealed smaller than normal lung volumes, a narrow effective cranial thoracic tracheal lumen, and hepatomegaly. Computed tomography showed a severe tracheal collapse of the cervical trachea, with practical closure from the fourth to seventh cervical vertebral bodies, and moderate-to-severe collapse of the remaining segments and mainstem bronchi (see Figure 1).

The dog was scheduled for tracheoscopy, followed by surgical correction of the tracheal collapse via endoscope-guided tracheal stent placement. After intramuscular premedication with acepromazine (Prequillan, Arovet AG, Dietikon, Switzerland, 0.01 mg/kg) and butorphanol (Morphasol, Dr. E. Graeud AG, Bern, Switzerland, 0.3 mg/kg), a 22 G intravenous catheter was placed aseptically in the left cephalic vein. The dog was subsequently preoxygenated for 5 minutes and general anesthesia was induced with intravenous propofol (Propofol 1% Fresenius, Fresenius Kabi AG, Oberdorf, Switzerland, 3 mg/kg) administered to effect to allow for endotracheal intubation. The 4.5 mm ETT was then connected to a circle breathing system to allow for 100% oxygen administration. Anesthesia was maintained with

a constant rate infusion of propofol (0.3–1 mg/kg/min, IV) and butorphanol (0.2 mg/kg/h, IV). A balanced crystalloid solution (Plasmalyte A, Baxter AG, Volketswil, Switzerland) was administered at a rate of 5 mL/kg/h throughout the procedure. The dorsal metatarsal artery was catheterized with a 24 G indwelling catheter to allow for arterial blood sampling and blood gas analysis. Monitoring (Dräger Sulla 808V equipped with Datex-Ohmeda S3 Monitor) included lingual pulse oximetry, sidestream capnography, electrocardiography, and Doppler (Ultrasonic Doppler Flow Detector, Model 811-B, Parks Medical Electronics, INC, Aloha, Oregon, USA) for noninvasive blood pressure measurements. Cardiovascular and respiratory variables were manually recorded at 5-minute interval. The ETT tube was left in place until the beginning of the stent placement, to ensure airways' patency while performing tracheoscopy. In order to allow for the visualization of the entire trachea, the proximal end of the ETT was pulled rostrally so that its caudal tip was positioned just distal to the tracheal inlet. Thereafter, the trachea was extubated to improve endoscopic field visibility during tracheal stent placement. A portable oxygen flowmeter equipped with a humidifier was connected, through a 7 mm female adaptor, with a 1-meter long silicon tube, whose free end was joined together with the proximal end of a 16 Fr. silicon-coated polyvinylchloride ureteral catheter, with an external diameter of 1.5 mm and a straight atraumatic tip (ERU ureteral catheter, Teleflex Medical, Athlone, Ireland). In order to optimize the gas flow to the lungs, several handmade orifices had been previously made with a sterile 21 G percutaneous needle at the free end of the catheter, starting from approximately 6 cm from the distal tip (see Figure 2). The ureteral catheter was inserted into the tracheal lumen so that its tip and that of the endoscope's insertion tube were parallel and moved in a synchronous manner with the latter in order to optimize surgical field visibility and, at the same time, patient oxygenation (see Figure 3). The oxygen flowmeter was set to deliver 2–3 L/min oxygen throughout the procedure.

Immediately after stent placement, the operator temporarily required withdrawal of the catheter to achieve a greater field visibility and check the stent position. On this occasion, a rapid drop in SpO₂ to 78% occurred; a blood gas

TABLE 1: Cardiovascular and respiratory variables recorded from an 11-years-old female Yorkshire Terrier during and after an endotracheal stent placement.

Variable	Reference range	Time point 1	Time point 2	Time point 3
Arterial blood pH	7.37–7.43	7.146	7.054	7.205
FiO ₂	0.21–1	0.21	ND	0.50
PaO ₂	95–108	83.6	240.3	120.4
SaO ₂	97–100	93.1	99.1	97.6
PaCO ₂	34–40	38	73.4	43.1
HR	70–110	118	120	ND
SAP	100–130	110	102	ND

FiO₂: inspired fraction of oxygen; PaO₂: arterial partial pressure of oxygen as measured by the blood gas analyzer (mmHg); SaO₂: arterial oxygen saturation as calculated by the blood gas analyzer (%); PaCO₂: arterial partial pressure of carbon dioxide as measured by the blood gas analyzer (mmHg); HR: heart rate (beats per minute); SAP: systolic arterial pressure as measured by Doppler (mmHg); ND: not determined; time point 1: during intratracheal stent placement, some minutes after oxygen supplementation was discontinued; time point 2: still during intratracheal stent placement, some minutes after oxygen supplementation was reestablished; time point 3: during recovery phase, with the animal being extubated and kept awake in the oxygen cage.

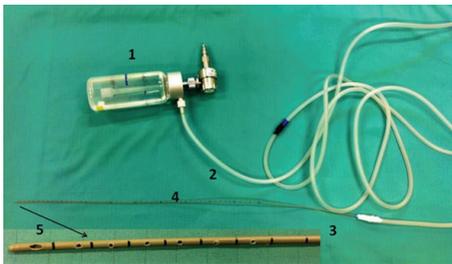


FIGURE 2: Handmade device developed to provide oxygen supplementation during tracheal stent. Placement: a portable oxygen flowmeter (1) is connected with a 1-meter long silicon tube (2). The free end of the silicon tube is joined together with the proximal end (3) of a 16 Fr. ureteral catheter (4), whose opposite end is modified with several handmade orifices (5) starting from approximately 6 cm from the distal tip.

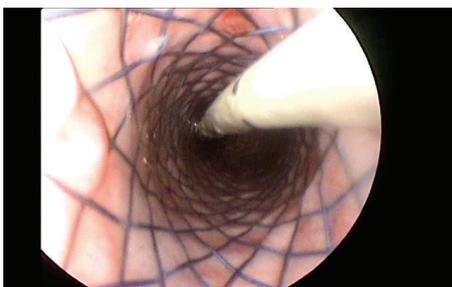


FIGURE 3: Endoscopic view of the tracheal lumen during the intraluminal stent placement. The white tube is the ureteral catheter used to provide oxygen supplementation.

analysis performed simultaneously confirmed the presence of hypoxemia (PaO₂: 84 mmHg; Table 1). The catheter was rapidly reinserted and oxygen supplementation was reestablished; this caused the SpO₂ to return to normal ranges. A new blood gas analysis confirmed an increase in a PaO₂ (240 mmHg), although at this time the dog was found to be moderately hypercapnic (PaCO₂: 73 mmHg; Table 1). At the end of the procedure, the dog was allowed to recover in

the intensive care unit of the hospital, in an oxygen cage set to deliver 50% oxygen. A blood gas analysis performed later with the dog staying awake revealed adequate oxygenation and ventilation (Table 1).

The day after, due to the occurrence of unexpected, sudden respiratory distress, further diagnostics were performed. Thoracic radiographs and tracheoscopy showed a complete tracheal collapse just distal to the stent's distal end and also a severe right bronchus collapse accompanied by right lung lobes atelectasis. Because of the poor prognosis, the dog was euthanized.

3. Discussion

To date, the literature pertaining to canine tracheal collapse has focused on various aspects of its pathogenesis and available treatment options [1, 3, 15, 16], but there is a lack of information regarding the anesthetic management when surgical correction of the tracheal narrowing is attempted. This case report describes the successful anesthetic and airways management of a dog affected by complete tracheal collapse during intraluminal stent placement by means of an innovative, practical, and inexpensive technique developed to maintain airway patency and, at the same time, provide effective oxygen supplementation.

Maintenance of airway patency and efficient oxygenation of the patient during intraluminal manipulation of a narrowed trachea may represent a real challenge for the anesthetist. Ideally, an airway access may be established by means of a catheter whose length, diameter, and physical properties would allow it to extend past the collapsed portion of the trachea, thus maintaining tracheal patency, while minimally interfering with the endoscopic field visibility during stent placement. Owing to its characteristics, the ureteral catheter we used fulfilled these requirements and allowed having safe, efficient, and practical airway management. The combination of silicon coating and atraumatic straight tip, together with the relative rigidity of a material such as polyvinylchloride, allowed for optimal remote control of the catheter's distal

end position, without resulting in iatrogenic damages of the tracheal mucosa. In this way, the catheter could be guided to and fro into the tracheal lumen so that its distal tip would always parallel the endoscope's end; as a result, oxygen supplementation was optimized, while good endoscopic field visibility was maintained.

Owing to technical reasons, we were unable to measure the percentage of oxygen delivered to the patient by means of this novel method. In order to have a reliable measurement of the inspired fraction of oxygen, the distal end of the side stream sampling line for the gas analyzer should have paralleled the catheter's tip into the tracheal lumen. However, the presence of another device into an already narrowed trachea would have greatly decreased the field visibility and potentially increased the likelihood of tracheal damages. Furthermore, because gas sampling lines are usually manufactured with flexible materials, it would have been technically difficult to guide the aforementioned line to and fro in the trachea while avoiding bending and turning. Placing the sampling line at the proximal tip of the catheter, for instance by means of a hypodermic needle, may have been more practical; nonetheless, the measurement would have been unreliable as values obtained in this way more likely reflect the oxygen concentration as delivered by the gas source that was close to 100%, rather than the one really inspired by the patient. Although the real oxygen concentration delivered by means of this technique cannot be determined, we assume that this was adequate, as it resulted in normal SaO_2 and acceptable PaO_2 values (Table 1). The sudden, dramatic drop in SpO_2 , SaO_2 , and PaO_2 occurring immediately after oxygen supplementation that was discontinued confirms the clinical usefulness of the described technique in terms of maintenance of airways' patency and improvement of patient's oxygenation. During the aforementioned critical event, the blood gas results showed inconsistency between SaO_2 calculation and SpO_2 reading. This discrepancy could have been due to inaccurate pulse oximeter reading owing to manipulation of the tongue during the procedure; however, it should be noticed that while the value was recorded, the probe was properly positioned and a pulse waveform was correctly displayed. As an alternative explanation, the SaO_2 could have been overestimated by the blood gas analyzer. Indeed, such value is calculated based on the equation developed by Severinghaus, which only provides an estimate as it does not account for differences in temperature, pH, and concentrations of 2,3 DPG in red blood cells. As a result, an error of measurement cannot be excluded.

An effective teamwork, characterized by coordinated courses of action and excellent communication between surgeons and anesthetists, played a key role and was essential for the successful outcome. Indeed, when performing such a delicate procedure, poor planning and miscommunication between clinicians may increase the risk of complications, such as patient hypoxia and entrapment of the catheter between the tracheal mucosa and intraluminal stent, resulting in iatrogenic damage of the airways' mucous membranes.

In order to maintain a stable anesthetic level and avoid environmental pollution, which in the present case would

have been unavoidable due to leakage of anesthetic gases through an unsealed connection between airways and fresh gas outlet, total intravenous anesthesia was selected as technique of choice. It was decided to administer propofol to maintain a stable anesthetic plane owing to its safety, short-context sensitive half time, and ease of use in constant rate infusion. Butorphanol was chosen as comaintenance agent due to its antitussive properties, which may improve the tolerance to the stent in the postanesthetic period and to the less pronounced respiratory effects in comparison to pure μ -agonists. However, these intravenous agents are not devoid of side effects and both carry the potential for respiratory depression [17]. Hypoventilation and hypercapnia, as revealed by the blood gas analysis performed after oxygen supplementation was restored, did occur in this dog. Because propofol rate of infusion had been increased shortly before blood sampling in response to a superficialization of the anaesthetic depth, this hypercapnia was interpreted as the result of a transient respiratory depression, which resolved spontaneously within a few minutes without causing patient hypoxia. The impossibility to intubate the trachea with an appropriate size endotracheal tube without interfering with the surgical procedure prevented us from initiating intermittent positive pressure ventilation. However, should severe propofol-related respiratory depression occur, discontinuation of the procedure, followed by prompt intubation of the trachea and initiation of positive pressure ventilation, is strongly recommended.

4. Conclusion

Oxygen supplementation via a nondistensible, atraumatic ureteral catheter inserted into the tracheal lumen during intraluminal stent placement allowed for satisfactory airway management and patient oxygenation, without interfering with surgical field visibility or with completion of the procedure.

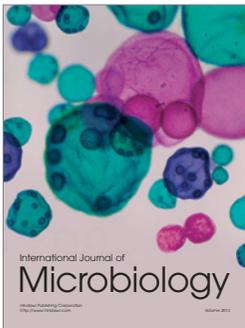
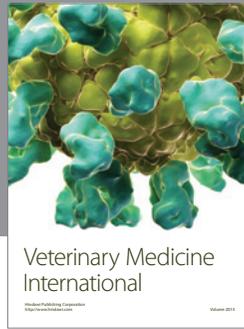
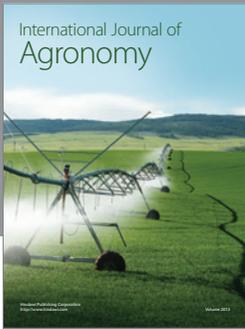
Conflict of Interests

The authors do not have any potential conflict of interests to declare.

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