The effect of inspiratory gas flow rate on the occurrence of post-intubation tracheal stenosis in birds

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Introduction

Hypothesis: Increasing the inspiratory gas flow rate of intermittent positive pressure ventilation (IPPV) during anesthesia will increase the incidence of post-intubation tracheal stenosis in birds.

Background: Anesthesia is an important tool in avian medicine, but it can pose certain challenges due to unique features of the avian respiratory tract. The avian trachea is supported by complete cartilage rings and narrows as it transverses in the craniol to caudal direction in many avian species, both of which predispose it to injury when intubated.1 2 One post-intubation complication frequently reported in birds is tracheal stenosis.3 Tracheal stenosis, or an abnormal narrowing of tracheal diameter, has been estimated to develop an average of 5-17 days following intubation, causing dyspnea and respiratory distress.4 5 6 Based on a case review of avian post-intubation tracheal stenosis, the estimated mortality rate for this condition is 70%, but the direct cause has not yet been determined.5 7

Materials and Methods

Animals: Six rock doves (Columba livia)

Methods: Each bird was anesthetized using a non-rebreathing anesthesia circuit and intubated with a 2.5-3.0 mm uncuffed endotracheal tube. The length of endotracheal tube in the trachea was measured to aid in localizing any tracheal lesions that developed after the procedure. IPPV was provided by a mechanical ventilator at 10 breaths per minute for a duration of 3 hours using a high inspiratory gas flow rate (5-1 second inspiratory time). The isoflurane concentration and end tidal CO2 were maintained at 1-3% and 30-40 mmHg respectively.5 8 Heart rate and rhythm, respiratory rate, body temperature, blood oxygen saturation, and indirect arterial pressure were monitored throughout the entire procedure.4 (Figure 1) Following the procedure, the birds were monitored daily for signs of respiratory distress for 14 days. At the end of the monitoring period, the birds were humanely euthanized. The trachea was collected, processed, and evaluated for evidence of inflammation, fibrosis, or stenosis. Any resulting lesions were graded for severity on a 0-3 scale based on size and histologic appearance.

Preliminary Results

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Anesthesia

- Serious, yellow mucus was present at the end of the endotracheal tube for four birds.
- Mild coughing, head shaking, gular flutter, and/or neck stretching behavior was observed immediately following extubation for the same four individuals. (Figure 4)

Post-Intubation Monitoring

Three birds showed respiratory signs during monitoring.

- Bird 1, Bird 2: Mild, progressive respiratory signs starting at day 11 and day 10 respectively, including increased respiratory rate and repeated swallowing behavior. The birds completed the full 14 day monitoring period.
- Bird 3: Moderate, progressive respiratory signs starting on day 1, including increased respiratory rate, increased respiratory effort, and swallowing behavior. On day 8 this bird began to exhibit signs of respiratory distress, including intermittent open beak breathing and head shaking behavior, therefore it was humanely euthanized prior to the full monitoring period.
- Bird 4, Bird 5, Bird 6: No respiratory signs.

Histopathology

Final histologic evaluation of the tracheae is currently pending.

- Normal Trachea: The histologic evaluation of a healthy avian trachea should reveal distinct layers. The tracheal lumen is lined by a ciliated, pseudostratified columnar epithelium that contains mucous glands. The mucus layer lies below the epithelium, followed by a layer of elastic lamina propria and submucosa, which also contain mucous glands. All of these layers are surrounded by complete cartilage rings and longitudinally oriented smooth muscle fibers.6 7 (Figure 2)

- Tracheal Stenosis: The narrowing of the tracheal lumen is caused by the granulation and/or fibrotic tissue that develops in the mucosa and submucosa after initial tracheal trauma.6 7 8 Edema, ulceration, epithelial attenuation, loss of cilia, and hyperplasia can also occur.5 8 9 (Figure 3)

Conclusion

Results: Based on preliminary results, additional tests are needed to clarify the correlation, if any, between inspiratory gas flow rate during IPPV and the occurrence of tracheal stenosis in birds.

Future Studies: A second group of six rock doves will be anesthetized using a high inspiratory gas flow rate (5-1 second inspiratory time) and 20 mmHg end tidal CO2 for 6 hours to further examine the apparent lack of correlation between inspiratory gas flow rate and tracheal stenosis formation. The laboratory also plans to investigate other factors hypothesized to influence the occurrence of avian post-intubation tracheal stenosis. These include the endotracheal tube cuff, the humidity of the anesthetic gas, movement of the endotracheal tube in the trachea during anesthesia, or infectious chemical residues on the endotracheal tube.5 6 7 The results of these experiments could have significant clinical implications for avian medicine and will aid in improving current avian anesthesia protocols utilized by veterinary clinicians.

References


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