Case Report Rapport de cas

Severe upper airway obstruction following bilateral ventral bulla osteotomy in a cat

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Abstract — A cat that underwent bilateral ventral bulla osteotomy (VBO) for treatment of otitis media and otitis interna secondary to bilateral inflammatory polyps, developed upper airway obstruction (UAO) soon after tracheal extubation. The cat was re-intubated but the UAO did not resolve at the next extubation. Eventually, tracheostomy was performed. Upper airway obstruction is a potential postoperative complication of bilateral VBO in cats.

Résumé — Grave obstruction des voies respiratoires supérieures chez un chat après ostéotomie bilatérale des bulles ventrales. Un chat qui a subi une ostéotomie bilatérale des bulles ventrales (OBBV) pour le traitement d'une otite moyenne et d'une otite interne secondaire à des polypes inflammatoires bilatéraux a développé une obstruction des voies respiratoires supérieures (OVRS) peu de temps après l'extubation trachéale. Le chat a été réintubé mais l'OVRS ne s'est pas résorbée à l'intubation suivante. Finalement, une trachéostomie a été réalisée. L'OVRS est une complication postopératoire potentielle de l'OBBV chez les chats.

(Traduit par Isabelle Vallières)

Can Vet J 2017;58:1313–1316

Complete upper airway obstruction (UAO) is a life-threatening condition requiring immediate intervention. Reported causes of UAO in cats include neoplasia, pharyngeal polyps, laryngospasm, trauma, foreign body, laryngeal paralysis, tracheal disruption, and severe idiopathic laryngeal or pharyngeal swelling (1). Significant pharyngeal swelling and consecutive UAO can occur after bilateral total ear canal ablation (TECA) and lateral bulla osteotomy (LBO) in dogs (2). In cats, UAO secondary to ventral bullae osteotomy (VBO) was mentioned in a study evaluating indications and outcome of tracheostomies in the feline species (3) but, to our knowledge, it has never been described before. This report describes the anesthetic management and postoperative care of a cat that developed UAO following bilateral VBO.

Case description

A 1.5-year-old, spayed female domestic shorthaired cat, weighing 3.1 kg, was referred to our neurological department for investigation of an acute onset of left-sided head tilt, ataxia, vomiting, and mild positional rotatory nystagmus. No history of recurrent otitis was reported and the upper airway was unremarkable at clinical examination. Magnetic resonance imaging (MRI) of the head showed that both bullae were filled with a relatively homogeneous material, which had a low signal in T1-weighted images and had a rim of strong mucosal contrast enhancement. More solid contrast enhancement was seen in the rostral compartments of both ears, in particular the left, possibly consistent with a polyp. The MRI changes were consistent with bilateral otitis media and otitis interna of the left ear only. Cerebrospinal fluid was collected at the end of the MRI and its analysis was unremarkable. Differential diagnosis included idiopathic, inflammatory, or infectious diseases and possible presence of bilateral inflammatory polyps. Recovery from anesthesia was uneventful. The cat was discharged with a 10-day course of clindamycin (Antirobe; Pfizer, Tadworth, Surrey, UK), 50 mg PO, q12h, and bilateral VBO was scheduled for 2 wk later.

The day before surgery the cat was admitted to the hospital. The cat was bright, alert, and in excellent body condition, the neurological signs were improved but a marked left head tilt was still present. Pre-anesthetic evaluation was unremarkable: heart rate (HR) was 150 beats/min (bpm), and the respiratory rate (RR) was 30 breaths/min (brpm). Abnormal upper respiratory noises were not detected. Hematology and biochemistry revealed only eosinophilia [3.34×10^9/L; reference interval (RI): 0.1 to 0.79×10^9/L] and mild hyperglobulinemia (54 g/L; RI: 28 to 51 g/L). Twenty minutes after administration of methadone (Comfortan; Dechra Veterinary Products, Shrewsbury, UK), 0.3 mg/kg body weight (BW), IM, general anaesthesia was induced with alfaxalone (Alfaxan; Vétoquinol, Great Slade, Buckingham, UK), 3.3 mg/kg BW, IV, and, after applying lidocaine spray directly on the larynx (with subjectively normal shape and function), tracheal intubation was performed with a 4.5-mm internal diameter cuffed endotracheal tube (ET).

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General anesthesia was maintained with isoflurane (IsoFlo; Abbott, UK) vaporized in oxygen and delivered using a pediatric Mapleson D breathing system in the preparation room and a circle system during surgery. During surgery, the animal was positioned in dorsal recumbency on an electrical heating blanket (Hot Dog; Augustine Temperature management, Eden Prairie, Minnesota, USA), with the neck fixed in an extended position using tape. To facilitate extension, a swab pack was placed under the neck. The cat was allowed to breathe spontaneously. Lactated Ringer's solution (Aqupharm Animalcare, York, UK) was infused at 5 mL/kg BW per hour, IV. Electrocardiography (ECG), oscillometric arterial blood pressure (O-NIBP), end-expiratory partial pressure of carbon dioxide ($PE'CO_2$), end-expiratory fraction of isoflurane (FE′Iso), pulse oxymetry (SpO_2) and esophageal temperature were monitored and recorded at 5-minute intervals (T5 Beneview; Mindray, Huntingdon, UK). After 30 min of anesthesia just before the start of the surgery, glycopyrrolate (Glycopyrronium Bromide; Martindale Pharmaceuticals, Romford, Essex, UK), 10 μg/kg BW, Ringer's lactated solution, 10 mL/kg BW, IV, and tetrastarch (Voluven; B Braun Medical, Shefield, UK), 2 mL/kg BW, boluses were administered IV in an attempt to increase heart rate (110 bpm) and blood pressure (MAP 40 mmHg), respectively. At this point FE′Iso was 1.1%. Normotension was re-established only after starting a constant rate infusion of dopamine (Dopamine Hydrochloride; Hospira, Warwickshire, UK) 4 μg/kg BW/min.

Ventral bulla osteotomy was performed as previously described (4). Material was found in both bullae; therefore, samples were taken for histological examination. Total duration of anesthesia was 90 min. Median HR was 150 bpm (range: 120 to 170 bpm), MAP was 60 mmHg (range: 30 to 90 mmHg), $PE'CO_2$ was 28 mmHg (range: 21 to 37 mmHg), temperature was 36.5°C (range: 36.2°C to 38.2°C), and SpO_2% was maintained between 98% and 100%. Fentanyl (Fentadon; Dechra Veterinary Products), 2 μg/kg BW, IV, was administered to control nociception in one occasion during the closure of the skin. At the end of the surgery, which was uneventful and lasted 60 min, the cat was positioned in lateral recumbency and isoflurane administration was discontinued. The cat was extubated 5 min later, when the pinna reflex reappeared. Immediately after extubation, an increase of inspiratory and expiratory efforts, dyspnea, and paradoxical breathing were noted; the upper airways were evaluated and a marked peri-laryngeal and peri-pharyngeal swelling was detected. Furthermore, the ventral cervical area appeared swollen. The cat became rapidly cyanotic despite flow-by oxygen administration. Alfaxalone, 1 mg/kg BW, IV, was administered to allow emergency tracheal intubation. A smaller ET tube (4-mm internal diameter) was placed using a rigid urinary catheter as a bougie. At this time HR was 180 bpm, RR 20 brpm, $PE'CO_2$ 51 mmHg, SpO_2 99%, MAP 70 mmHg, and temperature 36.6°C. Dexamethasone (Dexadrglycoeson; Intervet, Milton Keynes, UK), 0.2 mg/kg BW, IV, was administered and a cold pack was applied to the ventral cervical region. Anesthesia was maintained for 40 min with isoflurane delivered in oxygen using a circle breathing system, allowing the cat to breathe spontaneously. During this period median and range values of HR were 160 bpm (range: 150 to 170 bpm), respiration 20 brpm (range: 15 to 25 brpm), $PE'CO_2$ 48 mmHg (range: 40 to 53 mmHg), SpO_2 99% (range: 98% to 100%) and MAP 50 mmHg (range: 40 to 100 mmHg), FE′iso was 1.2%. Esophageal temperature remained constant at 36.6°C.

A second attempt to recover the cat from anesthesia and remove the endotracheal tube was made as a reduction of the cervical swelling was observed. However, despite the cat being initially able to breathe without evident UAO, respiratory distress and dyspnea developed 5 min after extubation. Alfaxalone, 1 mg/kg BW, IV, was then administered and the upper airways were examined: marked peri-laryngeal and peri-pharyngeal swelling was still present; therefore, the cat was re-intubated and phenylephrine (Phenylephrine injections BP; Amdipharm, Basildon, UK), 0.01 mg/kg BW, was splashed on the larynx. After discussion with the soft tissue surgeon in charge of the case, it was decided to explore the ventral cervical area and recover the cat with a temporary tracheostomy. Anesthesia was maintained with isoflurane delivered in oxygen using a circle breathing system. No obvious bleeding or other abnormalities were detected during surgical exploration. After placement of a tracheostomy tube (3-mm external diameter) the cat was allowed to recover from general anesthesia. Recovery was uneventful and the cat was able to maintain $SpO_2 > 95\%$ while breathing 21% oxygen. Buprenorphine (Vetergesic; Sogeval, Hutton, York, UK), 20 μg/kg BW, IV, was administered and repeated every 6 h as postoperative analgesia. The quality of recovery was excellent and the cat was constantly monitored for any signs of UAO overnight. The following day the cat was comfortable and able to breathe even when the tracheostomy tube was intentionally occluded; alfaxalone, 0.5 mg/kg BW, IV, was administered to evaluate the upper airway: the peri-laryngeal and peri-pharyngeal swelling was markedly reduced as was the ventral cervical swelling, thus, the tracheostomy tube was removed and the tracheostomy site was sutured. At 2 wk postsurgical re-examination the cat was bright, alert, and in excellent condition; no upper airway respiratory noises were present; the head was slightly tilted but there was no residual ataxia. Both surgical wounds and the tracheostomy site were completely healed. The results of histological examination were consistent with bilateral ear polyps.

Discussion

Upper respiratory obstruction has been commonly reported in brachycephalic canine breeds — brachycephalic obstructive airway syndrome — or in large breed dogs following unilateral or bilateral laryngeal paralysis (5). In cats, the most common causes of UAO are laryngeal masses, inflammatory laryngeal diseases, laryngeal paralysis, laryngospasm, tracheal disruption, and severe laryngeal or pharyngeal swelling (1). Upper airway obstruction following surgical procedures at the level of the ear canal is not a commonly reported complication. In dogs, UAO can occur due to significant pharyngeal swelling if total ear canal ablation (TECA) and lateral bulla osteotomy (LBO) are performed bilaterally (6) mainly related to edema, inflammation, and hemorrhage caused by the surgical access or in the early postoperative period due to encircling head bandages that can further constrict the pharynx, enhancing the obstruction (2). In

cats, VBO is often performed to treat otitis media, inflammatory polyps, and neoplasia of the middle ear. Horner's syndrome, facial paralysis, infections, otitis media, and vestibular syndrome are the most common postoperative complications associated with VBO in cats (7). To the authors' knowledge, UAO after VBO or other surgical procedures at the level of the ear canal has only been mentioned in a retrospective study evaluating indications, complications, and outcome of tracheostomy in cats (3). Swelling of the pharynx, larynx, and the surrounding soft tissue structures near the ear canal is likely to be the triggering event leading to UAO in the postoperative period (6). In cats, one of the most reported causes of UAO in the perioperative period is laryngospasm, which may occur after irritation of laryngeal tissue by secretions and/or blood, or by a direct stimulation during tracheal intubation or extubation, especially in presence of a light plane of anesthesia (8). Laryngospasm and laryngeal edema have been mainly associated with the use of xylocaine spray, due to the irritant effect of one of the excipients, rather than the drug itself (9,10). In this case lidocaine was used rather than xylocaine to desensitise the larynx and it was sprayed only during the first intubation; therefore, it seems unlikely that sprayed lidocaine could have triggered laryngeal edema or spasm. However, although intubation proceeded smoothly, we cannot completely rule out that the laryngeal stimulation during extubation could have triggered partial laryngospasm and therefore UAO. Upper airway obstruction developed immediately after extubation and, in our opinion, it was mainly caused by the presence of peri-laryngeal and peri-pharyngeal edema, and by direct external compression caused by the swelling of the ventral cervical area.

The severity of UAO clinical signs, which depends on the degree of functional obstruction and the underlying etiology, dictates the initial therapeutic approach. Clinical signs of UAO in cats can be mild like voice change, gagging, retching, cough, dysphagia, weight loss, and anorexia or severe dyspnea, paradoxical breathing, inspiratory and/or expiratory stridor (11). Depending on the severity, UAO impairs ventilation causing hypercapnia, hypoxemia, stress, and increasing oxygen requirement. This is accompanied by a compensatory increase of RR and effort; according to the Bernoulli effect, the increased velocity through an obstruction decreases upper airway pressure, worsening the airway diameter and efficiency of ventilation. Furthermore, the increase of respiratory effort and consequent muscular work increase body temperature, which might further increase RR. If not promptly resolved, UAO can lead to non-cardiogenic pulmonary edema, hypoxemia, collapse and death (12). Medical interventions in the case of UAO include sedation of the patient, administration of oxygen, active cooling, and short-acting glucocorticoids. Sedation reduces stress, oxygen consumption, RR, effort, and development of hyperthermia. Cold water, low environmental temperature, and the use of a fan might be helpful to reduce body temperature. Oxygen might be beneficial to increase arterial oxygen content and therefore oxygen delivery, especially if achieved in a non-stressful way (5). In severe UAO, or when medical treatment fails, intubation is strongly recommended to restore airway patency by by-passing the obstruction (11). In the present case, the cat showed marked respiratory distress and cyanosis not responding to flow-by oxygen administration. The cat's trachea was promptly re-intubated with the help of a stylet as peri-laryngeal swelling and secretions did not allow clear visualization of the larynx.

As previously recommended (5), a short-acting corticosteroid was administered to try to decrease inflammation and reduce soft tissue edema. Corticosteroids reduce the production of tissue transudate and cell edema in acute inflammation, inhibiting the release of inflammatory mediators and decreasing capillary permeability (11). In humans, high-dose corticosteroids were effective in improving dyspnea caused by neoplastic obstruction of the upper airways (13). Moreover, they were effective in reducing the incidence of post-extubation laryngeal edema (14). Nevertheless, dexamethasone was ineffective in reducing peri-laryngeal and soft tissue edema in the present case. The recommended dose of dexamethasone in dogs and cats ranges between 0.1 and 1 mg/kg BW (15); it is possible that the dose used here was insufficient. It is also possible that we did not allow enough time for dexamethasone to work. Although dexamethasone has rapid onset of action, in humans about 12 h were needed to relieve dyspnea caused by UAO after administration of dexamethasone (13). In this case, we maintained the cat anesthetized for only 40 min before re-attempting recovery. In humans, corticosteroids are commonly nebulized to treat UAO (16). The efficacy of nebulized corticosteroids (budesonide), intramuscular dexamethasone, and placebo were compared in children suffering from acute viral laryngotracheobronchitis (croup), causing UAO. Both nebulized budesonide and dexamethasone resulted in more rapid clinical improvement than placebo, with dexamethasone offering the greatest improvement (17). In our case, nebulized corticosteroids were not applicable due to the severity of obstruction requiring immediate re-intubation of the trachea under anesthesia.

A cold pack was also applied to the skin of the ventral neck to try to reduce the swelling and soft tissue edema. The use of local cryotherapy is based on the reduction of the skin and tissue temperature promoting vasoconstriction and subsequently a decrease of neuronal activity and arterial and capillary blood flow, thereby minimizing fluid leakage and edema (18). However, application of local hypothermia should be limited to multiple short sessions (5 to 15 min) to prevent reflex vasodilation and edema (19). In our case cryotherapy was applied for 30 min and although it was able to partially reduce the external soft tissue swelling it was not effective in decreasing the compression of the upper airways. It is possible that the application time was not adequate, or multiple cryotherapy sessions would have been required to decrease the temperature and the edema of deeper tissues.

In humans, phenylephrine has been reported to treat severe asthma and edema of the airways (20). Phenylephrine is a sympathomimetic amine with potent α-1 agonist effects, it is a potent vasoconstrictor and it is used for the beneficial effect of reducing mucosal thickness and plasma extravasation, thereby increasing airway calibre. To the authors' knowledge, there are no clinical studies evaluating the use of phenylephrine in cats to address laryngeal edema. Experimental studies have used cats as a model to compare the effect of phenylephrine spray (0.3% to 1%) and a specific α-2-adrenoceptor agonist for treatment

of nasal congestion. Both drugs demonstrated decongestant activity, mediated by vasoconstriction, with transient systemic cardiovascular effect (hypertension that lasted between 15 and 60 min) (21). In our case, phenylephrine spray was not available and a total dose of 0.01 mg/kg BW of injectable phenylephrine was topically applied directly on the larynx. It was impossible to evaluate the potential beneficial effect of phenylephrine in this case because immediate re-intubation was necessary. Hypertension was not observed. Considering the poor response to medical treatment and the severe respiratory distress shown by the cat after extubation, temporary tracheostomy was performed. Procedures for performing temporary and permanent tracheostomies have been described and are routinely used in dogs and cats (22,23). Temporary tracheostomies are normally used to bypass the obstruction for a short period of time. Indications for a temporary tracheostomy include UAO, trauma, and neoplasia or ventilated patients in intensive care setting. Compared to dogs, cats with tracheostomy are considered to be at higher risk of complications, due to a combination of increased production of mucus and a smaller trachea, which may not allow adequate ventilation around the tracheostomy tube in the event of a partial or total occlusion (22). In a more recent study, the major complications associated with temporary tracheostomy in cats were dislodgment and occlusion of the tracheostomy tube; minor complications included increased RR and respiratory effort associated with partial obstruction of the tracheostomy tube, hyperthermia, pneumomediastinum, subcutaneous emphysema, edema at the tracheostomy site, Horner's syndrome, laryngeal paralysis and cough (3). In the case herein, the cat did not experience any complications and the tracheostomy tube was removed the day after the surgery. The lack of complications could be related to the short period of time that the tube was left in place or to the thorough management of tracheostomy patients in our clinic. All tracheostomy patients are monitored hourly for increased RR or effort and the tracheostomy site is examined and nebulized every 4 h. Cleaning and suction are performed as necessary and a kit containing material for emergency intubation is normally kept on the cage door.

Upper airway obstruction should be considered as a possible complication after VBO in cats, especially when performed bilaterally. Thorough postoperative monitoring is advocated and prompt intervention is needed in cases of severe UAO. Temporary tracheostomy needs to be considered when medical management fails. CVJ

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