

## ANESTHETIC MANAGEMENT OF CRITICAL SMALL ANIMAL PATIENTS WITH TRAUMATIC DIAPHRAGMATIC HERNIA AND GASTRIC DILATATION/VOLVULUS SYNDROME – A REVIEW

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### ABSTRACT

Successful anesthetic management of critical patients requires usage of specific anesthetic protocols depending on the animals' condition, degree of emergence, available equipment, knowledge of doctors etc. Correctly preoperative evaluation, intraoperative monitoring and postoperative monitoring and pain management are the important steps for decreasing of mortality during these conditions.

The aim of this article was to review procedures regarding Gastric Dilatation-Volvulus syndrome (GDV) and Traumatic Diaphragmatic Hernia (TDH), two common emergency situations in small animal practice, which share high mortality rates and the need of specific and cautious anesthetic considerations.

**Key words:** Gastric Dilatation-Volvulus syndrome (GDV), Traumatic Diaphragmatic Hernia (TDH), anesthesia, dog, cat

### INTRODUCTION

This article aims to review procedures regarding Gastric Dilatation-Volvulus syndrome (GDV) and Traumatic Diaphragmatic Hernia (TDH), two common emergency conditions in small animal practice, which share high mortality rates and the need of specific and cautious anesthetic considerations (3,5,7, 10, 12,13,14).

In the article, the whole management, from the anesthesiologist's point of view will be explained in detail, from presentation of the patient to recovery. Traumatic Diaphragmatic Hernia is a common emergency condition both in dogs and cats. TDH occurs, following trauma to the abdomen, which increases intraabdominal pressure. Depending on the location of the rupture, organs may herniate, with the liver being the most common organ to do so. Other organs such as the small intestine and pancreas usually herniate in right-sided ruptures, while the spleen and the stomach usually herniate on left sided tears of the diaphragm (4,8,). A characteristic respiratory pattern is observed in these patients (abdominal) that are usually presented with dyspnea and compensatory polypnea due to the loss of intrathoracic negative pressure (6,11).

Gastric Dilatation-Volvulus syndrome is an acute, life threatening condition that affects primarily large-breed, deep-chested dogs. The etiology of the condition is still unknown, but many determining factors are known as voracity, post-prandial activity, anatomic predisposition, laxity of ligaments etc. It is not clear if volvulus or dilatation occurs first. In volvulus, the pylorus of the stomach, along with the duodenum migrate cranially, gas accumulates and cannot escape, causing the final presentation of the organ. Rotation may be anywhere from 90 to 360 degrees (1,2,9).

Patients are usually presented as restless, with an apparent abdominal distention, hypersalivating, in severe pain and trying, but not being able to vomit.

#### Manipulations before anesthesia:

Before any sedation is applied, in both cases patients should be stabilized by administration of IV fluids. While in TDH 10 ml/kg/hr of saline/dextrose 5% solution (13), which could go up to 20 ml/kg/hr if needed (5) is usually enough, in patients with GDV fluid therapy should be very aggressive, in order to reverse hypovolemia and improve perfusion. These patients require both



cephalic veins to be catheterized (1,3). Saphenous veins cannot be used because compression of v.cava caudalis impedes venous return from the hind part of the body (3). Crystalloids (eg: Ringer-Lactate) should be used from a rate of 50 ml/kg/hr (3) to even 90 ml/kg/hr (1) until heart rate drops below 150 bpm and blood pressure is above 90 mmHg.

**Haemoglobin-Based-Oxygen-Carriers (HBOC)** are a new method, still under trial, which could be used for initial resuscitation-therapy because they not only improve oxygen carrying capacity of blood but also increase both colloid and oncotic pressure (3).

A second, very important step is to stabilize the respiratory activity of the patient. In TDH this is done by preoxygenation (13,16). In this way, hypoxemia between induction and maintenance will be prevented. Flow-by administration of oxygen is preferred over mask because it is less stressful to the animal. Patients with pleural fluids or pneumothorax should undergo thoracocentesis, in order to extract fluids/air from the thoracic cavity, thus preventing respiratory distress (14). On the other hand, in patients suffering from GDV, decompression of the dilated stomach either by orogastric tube, which is not always possible to apply, or by gastrocentesis, relieves pressure on the diaphragm, restoring normal tidalic volume and decompressing the caudal vena cava and vena portae, thus helping venous return (3).

## PREMEDICATION AGENTS:

Regarding TDH, most authors suggest not to premedicate at all, especially in severely depressed and dyspnoic patients (5, 13). In stable patients, drugs that suppress the respiratory and cardiovascular activity should be avoided. These include primarily barbiturates and  $\alpha$ -2 agonists (16).

**Opiates:** While some authors suggest to avoid the use of opioids in DTH, their low effect on cardiac output, blood pressure, oxygen delivery and heart contractility, associated with the fact that patients will be intubated and receiving 100% oxygen, makes their use in patients with TDH relatively safe (6). In patients with GDV, they are the premedicants of choice, because of their great analgesic effect (3). While in dogs there is a wide choice of opioids to use, in cats only buprenorphine and butorphanol seem safe enough.

**Benzodiazepines:** Is the category that best suits patients with TDH, due to their minimal effect on ventilation and heart rate, their anxiolytic effects and smooth sedation (11,17). In patients with GDV, apart from these, their low effect on blood pressure is extremely helpful (9).

**Acepromazine Maleate:** Although mentioned by some authors (8), its negative effects overwhelm the beneficial ones. It can cause splenic enlargement (which is usually one of the herniated organs in TDH and is usually involved in GDV), it has no analgesic effect, causes vasodilation with subsequent hypovolemia (3) and cannot be used in brachycephalic breeds due to the risk of syncope.

**Anticholinergics:** Should be avoided because increased heart rate potentiates ventricular arrhythmias (15).

## INDUCTION AGENTS:

**Propofol:** Although one of the fastest inducting agents, and one of the most commonly used, it is not the agents of choice both in patients with TDH and GDV. This is because propofol is a very strong respiratory depressant (4), which can provoke long periods of apnea. Another drawback is that propofol causes marked hypotension and increased myocardial irritability (15).

**Thiopental:** A very old barbiturate. It has cumulative effect and causes depression of cardiac contractility and subsequent hypotension with compensatory tachycardia (17). It causes splenic enlargement so it is dangerous both for patients with TDH and for those with TDH. If it is the only available drug, it must be associated with Lidocaine 2 mg/kg IV to reduce the needed dose and to protect against arrhythmias.

**Ketamine:** One of the drugs of choice, usually combined with a benzodiazepine, it supports heart function, blood pressure and provides good somatic analgesia, without depressing ventilation (4,17).

**Etomidate:** The drug of choice in patients who are cardiovascular unstable. It does not depress heart contractility and does not alter heart rate. One of the main drawbacks is the immunosuppressing effect it has at high and/or repeated doses (15).

**Alfaxalone:** A recently re-invented drug. It has similar sedative effects with propofol, but without its effects on heart rate, respiratory rate and blood pressure (2).

## MAINTENANCE DURING ANESTHESIA:

Maintenance of anesthesia in both patients with GDV and TDH should be performed with an inhalatory anesthetic at the lowest possible rate to prevent hypotension. This is extremely important in cases of GDV, so usually a CRI of fentanyl is used to decrease dose of inhalatory agent. IPPV is mandatory (4,5,8,13,16) in TDH cases and is advised in GDV cases. Tidalic volume should be 10-15 ml/kg (7). Respiratory rate should be from 8-10 to 15 bpm (8,16) with an Inspiration/Expiration rate of 1:2 to 1:3, to prevent respiratory acidosis (7).

## MAIN INTRAOPERATIVE ANESTHETIC COMPLICATIONS:

**Hypotension** is of different origin in each condition. In patients suffering from TDH, a sudden episode of hypotension arises right after organ repositioning, due to vasodilation (15). On the other hand, in patients with GDV, this is a consequence of the compression of the caudal vena cava, resulting in blood not being able to return to the heart. In both cases, this complication is dealt with by vasoactive therapy. Large amounts of crystalloids can be used in patients with GDV but not in patients with TDH, because subsequent hypervolemia will induce lung edema. In both cases, intravenous infusion of inotrope drugs such as Dopamine or Dobutamine are useful (5-7 $\mu$ g/kg/hr), while Ephedrine (0,06mg/kg IV bolus) is another, less commonly used option (15).

**Reexpansion Pulmonary Edema-** In cases of TDH, where the lungs have been collapsed for more than 12 h, reexpansion should not be abrupt but rather gradual. The sudden pressure will activate cytokines, provoking a condition caked "Reexpansion Pulmonary Edema" (15). The use of methylprednisolone has been shown to avoid this condition from arising (5).

**Arrhythmias**-Is a very common complication in patients with GDV, mainly postoperatively, but it may also occur during general anesthesia. A lot of factors may provoke arrhythmias like hypotension, endotoxins released with reperfusion of tissues, hypoxia, hypokalemia or even pain. Antiarrhythmic drug of choice is Lidocaine (3 mg/kg IV bolus followed by CRI 50 $\mu$ g/kg/min) (5).

## SUGGESTED SPECIFIC PROTOCOLS FOR TDH:

**Protocol No1:** (according to Vesal, Parizi – 2011) *Premedication:* Morphine 0,5mg/kg IV

*Induction:* (Diazepam 0,2 mg/kg + Ketamine 4 mg/kg) combination. Lidocaine spray on larynx is recommended to facilitate intubation.

*Maintenance:* Isoflurane 1,5 - 2% with IPPV 15 bpm and Inspiration:Expiration 1:2. Reduction of IPPV rate to 10 bpm is recommended to stimulate spontaneous breathing.

**Protocol No 2:** (according to Das, Jena, Behera – 2016) *Premedication:* Without any premedication.

*Induction:* Midazolam 0,2mg/kg + Ketamine 6mg/kg IV combination.

*Maintenance:* Isoflurane 1,5-2% IPPV.

**Protocol No 3:** (according to Fossum - 2013)

*Premedication:* Without premedication in dyspnoic/depressed patients. In stable patients Diazepam/Midazolam 0,1-0,2 mg/kg.

*Induction:* Propofol (2-4 mg/kg, 4-8mg/kg if not sedated) in patients with normal cardiac function. In patients with compromised cardiac function Etomidate, 5-1,5 mg/kg IV

*Maintenance:* Isoflurane or Sevoflurane plus:

1) Fentanyl 2-10 µg/kg IV + Fentanyl CRI 1-5 µg/kg IV loading dose, then 2-30 µg/kg/hr or 2) Buprenorphine 0,005-0,02 mg/kg IV + Ketamine 0,5-1 mg/kg IV or 3) Ketamine CRI 0,5 mg/kg loading dose, then 10 µg/kg/min.

**Protocol No 4:** (according to Trim - 2008 - for cats)

*Premedication:* Buprenorphine 0,01 mg/kg or Butorphanol 0,2-0,4 mg/kg

*Induction:* Midazolam 0,25 mg/kg + Ketamine 5 mg/kg IV

*Maintenance:* Isoflurane or preferably Sevoflurane 1,5-3 %

**FOR DOGS** *Premedication:* Oxymorphone 0,05-0,1mg/kg IV or either Buprenorphine 0,01 mg/kg or Butorphanol 0,2 mg/kg. Oxymorphone should not be used in cats because it produces profound dysphoria. In dogs it may induce vomiting, so it would be wiser to use it intraoperatively. If Butorphanol is used, other opiates cannot be used intraoperatively, because they will be antagonized by it.

*Induction:* Diazepam/Midazolam 0,2 mg/kg + Ketamine 4 mg/kg or Etomidate 1-1,5 mg/kg IV in cats and small dogs, 0,5-1mg/kg in larger dogs or Fentanyl 6-10 µg/kg IV and Midazolam 0,25 mg/kg IV, placed in different syringes. 1/3 of the dose of each drug is given, flushing in between them and the animal is observed for induction status. Due to the short action of Fentanyl, Intraoperative CRI of 6 µg/kg/hr is needed.

**Protocol No 5:** (according to Plunkett - 2013)

*Premedication:* Without any premedication

*Induction:* In cardiovascularly stable patients: Hydromorphone + Midazolam or Ketamine 4mg/kg + Diazepam 0,2 mg/kg or Propofol 2-6 mg/kg

In cardiovascularly unstable patients: Etomidate 1-2 mg/kg IV

*Maintenance:* Isoflurane or Sevoflurane 1-2 %

**Protocol No 6:** (according to Ilievská - 2014)

*Premedication:* Acepromazine Maleate 0,2 mg/kg IM, Ketoprofene 10 mg/kg IM

*Induction:* Ketamine 10 mg/kg IM

*Maintenance:* Isoflurane 1,5-3 % IPPV 8-10 bpm. Aminophyllin 6 mg/kg to helps the ventilation.

## PROTOCOLS FOR PATIENTS WITH GDV:

**Protocol No1:**

*Premedication:* Fentanyl 2-4 µg/kg IV or Oxymorphone 0,1 mg/kg IV

*Induction:* Diazepam/Midazolam 0,25-0,5 mg/kg IV. If needed, low doses of Propofol (1mg/kg) to help with intubation.

**Protocol No2:** (according to Judge - Cert) for stable patients:

*Premedication:* Fentanyl 2-10 µg/kg IV

*Induction:* Ketamine 6 µg/kg + Diazepam 0,2 mg/kg

For unstable patients:

*Premedication:* Without premedication

*Induction:* Fentanyl 2-4 µg/kg, Midazolam 2 mg/kg + Ketamine 4 mg/kg

*Maintenance:* Lidocaine and Ketamine CRI (Loading dose of Lidocaine 2 mg/kg and Ketamine 3mg/kg, then CRI 100 µg/kg/min of both drugs, which can decrease Sevoflurane MAC by 62,8 %)

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## CONCLUSIONS

Anesthesiologists and practitioners should be careful when the patient is in one of these conditions. The anesthetic protocol must be chosen on the base of severity of the problem and

current condition of the animal. The application of anesthesia for these critical patients is necessary but very dangerous. The mortality rate is over 50 %.

## REFERENCES

1. Brockman, D. J. (2008). Gastric Dilatation and Volvulus: Diagnosis and Stabilisation, Proceedings of the 33<sup>rd</sup> World Small Animal Veterinary Congress, Dublin, Ireland.
2. Broome, C. J., Walsh, P. (2003). Gastric Dilatation – Volvulus in Dogs, New Zealand Veterinary Journal, December, 51(6):275-83.
3. Cummings, K., Wetmore, L. (2014). Top 5 emergencies requiring anesthesia, <https://www.cliniciansbrief.com/>
4. Das, J., Jena B., Behera, S. S. (2016). Surgical management of feline traumatic diaphragmatic hernia – A case report. Journal of Livestock Science, 7:107-110.
5. Fossum, T. W. (2013). Surgery of the lower respiratory tract: Small animal surgery. Elsevier, 2013:1002-1007.
6. Grubb, T. (2010). Anesthesia for patients with respiratory disease and/or airway compromise. Topics Companion Animal Medicine, 25:120-132.
7. Hartsfield, S. M. (2007). Airway management and ventilation, In: Tranquilli, D. J. – Thurmon, J. C. and Grimm, K. A. Lumb and Jones' Veterinary Anaesthesia and Analgesia (4<sup>th</sup> edition), Blackwell: 495-531.
8. Ilievska et al. (2014). Anesthetic Management and Surgical Repair of Diaphragmatic Hernia in Cat: Case Report. Days of Veterinary Medicime 2014, 5<sup>th</sup> International Scientific Meeting, Ohrid, F.Y.R.O.M.
9. Judge, P.R., Cert, P.G., Gastric Dilatation Volvulus Syndrome, <https://veteducationcourses.com.au/>
10. Ko, J. (2013). Small Animal Anesthesia and Pain Management, Manson Publishing. Page: 286
11. Kushner, L. I. (2002). Respiratory Diseases, In: Greene SA, Veterinary anaesthesia and pain management secrets (1<sup>st</sup> edition):325-328.
12. Paddleford, R.R., Greene, S. A. (2007). Pulmonary disease, In: Veterinary Anesthesia and Analgesia (4<sup>th</sup> edition), Blackwell: 899-902.
13. Plunkett, S. J. (2013). Emergency procedures for the small animal Veterinarian. Elsevier:2013 161-162.
14. Slensky, K. (2009). Thoracic trauma, In: Small Animal Critical Care Medicine (1<sup>st</sup> edition), Elsevier:2009: 662-667.
15. Trimm, C. (2008). Anesthesia for Thoracic Surgery, CVC in Washington DC Proceedings.
16. Vesal, N., Meimandi Parizi, A. (2012). Anesthetic management of diaphragmatic hernia repair in a dog: A case report and literature review of anesthetic techniques. Iranian Journal of Veterinary Research: Vol. 13,(2): 156-160.
17. Viganò, F. (2013). Manuale di Pronto Soccorso nel Cane e nel Gatto. Edra. Pages: 113-116.