Gastric dilatation and volvulus. Part 1: Diagnosis and patient stabilisation

Jennifer McGinnity MVB MRCVS

Elizabeth M. Welsh BVMS PhD CertVA CertSAS MRCVS

Vets-Now Referral, 123–145 North Street, Glasgow, G3 7DA, UK

Jennifer McGinnity MVB MRCVS

Jennifer graduated from University College, Dublin, in 2015 and works as a rotating intern at Vets-Now Referrals (Glasgow Hospital). She has a special interest in small animal surgery.

Elizabeth M. Welsh BVMS PhD CertVA CertSAS MRCVS

Liz graduated from the University of Glasgow Veterinary School in 1989. She works for Vets-Now Referrals (Glasgow Hospital) as a referral clinician in soft tissue surgery.

ABSTRACT: Gastric dilatation (GD) involves the abnormal accumulation of fluid and/or air within the stomach. It may occur in isolation or be associated with volvulus of the stomach: this is referred to as gastric dilatation and volvulus (GDV) and it is an acute, life-threatening syndrome, which primarily, but not exclusively, affects large-breed dogs. It has rarely been recorded in cats and small mammals. The survival of patients with GDV relies on prompt diagnosis and effective emergency stabilisation prior to surgical intervention. This article will discuss the predisposing factors for GDV as well as the diagnosis and discuss the important aspects of initial patient stabilisation.

Predisposing factors

There are a wide number of predisposing factors for the development of gastric dilatation and volvulus (GDV). The following are some of the most commonly reported (Bell, 2014):

- pure breeds are at a higher risk compared to mixed breeds; German Shepherd, Standard Poodle, Great Dane, Weimaraner, Labrador Retriever, Bassett Hound and Irish Setter are over-represented
- dogs with parent(s), siblings or offspring that have been affected with GDV are at greater risk of developing the problem
- increasing age
- those dogs with a higher chest depth to width ratio are thought to be at greater risk of developing GDV, e.g. the Irish Setter
- thin/lean body-condition score
- feeding small-size nuggets of dry food only
- feeding once daily
- stress/anxiety/nervous temperament

Splenectomy has previously been reported as a risk factor. This is thought to be due to increased gastric movement following splenectomy (Sartor, Bentley, & Brown, 2013). However, in a more recent study, the relationship between the two conditions was shown not to be closely correlated (Grange, Clough, & Casale, 2012). Historically, gastric motility disorders were linked to the development of GDV, but there is little evidence to support this theory (Kazzola & Nelson, 2014).

Pathophysiology

It is unclear whether gastric dilatation (GD) develops first, predisposing to volvulus, or if volvulus occurs, leading to GD. In either event, GD is caused by the accumulation of large amounts of gas and/or fluid within the lumen of the stomach, while volvulus is rotation of the stomach, in a clockwise or anticlockwise direction, around its long axis. The latter causes, or contributes to, the accumulation of gas and fluid within the lumen of the stomach. Clinically, these events have consequences for a number of body systems in addition to the gastrointestinal tract, in

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particular the cardiovascular and respiratory systems.

Cardiovascular effects

Patients with GDV commonly present showing signs of shock as blood flow is inadequate to meet the oxygen demands of the body tissues. This occurs for a wide variety of reasons in GDV. Patients may be vomiting and this, in association with haemorrhage (see below) and third-space fluid losses, can cause *hypovolaemic shock*.

Significant gastric distension leads to compression of the caudal vena cava and the hepatic portal vein, causing a decrease in venous return to the heart. This can be so severe that it can decrease cardiac output by up to 50%. This is termed *obstructive shock*. The obstructed blood flow pools within the abdominal organs (the so-called splanchnic parenchyma) causing relative hypovolaemia, termed *distributive shock* (Sharp, 2015).

As a result of stagnant blood flow in the splanchnic circulation, disseminated intravascular coagulation (DIC) can be triggered. However, it is important to remember that other systemic abnormalities that may be occurring at the same time may also play a role in the development of DIC; these may include hypoxia, endotoxaemia, acidosis, widespread inflammation or tissue necrosis of, for example, the gastric wall.

Finally, patients may also suffer from *cardiogenic shock* as a consequence of, among other things, myocardial ischaemia. Myocardial ischaemia clinically manifests as arrhythmias, most of which are ventricular in origin. This is mainly noted by the presence of ventricular premature complexes on an ECG trace.

Respiratory effects

The severity of gastric distension is closely correlated with the severity of the respiratory signs present. Gastric distension puts pressure on the diaphragm. This not only physically restricts the movement of the diaphragm during inspiration, but also reduces the functional residual capacity (FRC) of the lungs at the end of expiration. The latter effect is particularly significant around the time of anaesthesia as the time to the onset of critical hypoxia can be reduced as a result of a decrease in FRC.

Aspiration of gastric fluid and saliva peri-operatively is a well-documented risk for patients with GDV. A recent study has suggested that thoracic radiographs should be taken for this reason (Green, Cimino Brown, & Agnello, 2012), but it is accepted that this may not always be possible or appropriate in the emergency setting.

Gastrointestinal effects

Dilatation of the stomach in GDV increases pressure on the gastric wall and this affects blood flow within the wall. Rotation of the stomach causes obstruction of many of the blood vessels that supply it with blood. Tearing of the short gastric and splenic arteries can cause haemorrhage. This not only contributes to hypovolaemic shock (see above), but also further compromises blood flow to the stomach wall.

These factors all increase the risk of ischaemia of the gastric wall, which may lead to necrosis. This is significant because the presence of gastric necrosis is recognised as a negative prognostic factor in GDV.

Recent studies have investigated the role of pepsinogens (inactive proenzymes secreted by the chief cells within the gastric mucosa) in order to assess gastric-wall viability pre-operatively. When interpreted alongside plasma lactate concentrations (see below), pepsinogens have been found to be a useful prognostic indicator (Israeli et al., 2012). Unfortunately, this test is not available in practice for veterinary patients.

The compromised gastrointestinal barrier also increases the risk of bacterial translocation, placing patients with GDV at a high risk of developing endotoxaemia and sepsis (Winkler, Greenfield, & Schaeffer, 2003).

Spleen

The spleen's anatomical proximity to the stomach predisposes to tearing and avulsion of the splenic vessels and splenic torsion. Consequently, it is important to evaluate the spleen at the time of surgery. Splenectomy should not be performed routinely, only in response to clinical need. Nevertheless, splenectomy is considered a poor prognostic indicator for patients with GDV, probably due in part to the increase in surgery time required.

Other effects

In addition to the gastrointestinal, cardiovascular and respiratory effects mentioned above, patients with GDV frequently also suffer from renal compromise and acid/base and electrolyte abnormalities. As the patient is in shock, inadequate circulatory blood flow can lead to decreased renal perfusion. Therefore, if steps are not taken to re-establish the circulating vascular volume to a level where blood flow to the kidneys is restored, acute kidney injury may occur as a consequence.

Many patients with GDV have complex mixed acid–base disorders. In general, metabolic alkalosis is commonly encountered early in the course of the disease due to acid trapping in the stomach lumen. This is usually followed by metabolic acidosis due to anaerobic metabolism and production of lactic acid. Patients may also experience a respiratory acidosis due to hypoventilation and subsequent hypercapnia.

Electrolyte abnormalities such as hypokalaemia, hypochloraemia, hypernatraemia and hyper-/hypoglycaemia are also commonly encountered.

Diagnosis

History and clinical signs

The onset of clinical signs is usually acute in nature. Owners typically report restless behaviour followed by hyper-salivation, non-productive retching and abdominal distension with sudden onset of weakness/collapse (**Figure 1**). These signs, although relevant, are relatively non-specific. Therefore, they must be interpreted in conjunction with the results of findings on physical examination.

Physical examination

The findings on examination reflect directly the pathophysiology of GDV as outlined above:

Figure 1. A Great Dane with GDV showing signs of mental depression and hypersalivation
Credit: © Elizabeth M. Welsh

- collapse
- dull/depressed mentation
- pale/tacky mucous membranes with a prolonged capillary refill time (CRT)
- tachycardia ± arrhythmias
  - weak/thready peripheral pulses ± pulse deficits
- respiratory distress, tachypnoea and evidence of hypoxia, i.e. cyanotic mucous membranes
- distended tympanic abdomen with associated abdominal pain

In very deep-chested patients it is important to remember that initially the abdomen may not appear distended as the stomach will be "hidden" within the rib cage. Consequently, percussion of the chest and abdomen is an important part of the physical examination.

Clinical pathology

Blood should be collected at the time intravenous catheters are placed and used to establish, at the very least, a minimum database (MDB). A MDB usually includes packed cell volume (PCV), total solids (TS), glucose and urea amongst other parameters, depending on practice protocols. The PCV and TS are frequently elevated in affected patients due to haemoconcentration. Elevation in blood urea concentration is not unusual due to the pre-renal effects of shock. Electrolyte and blood gas disturbances are common in animals with GDV and so, although not part of the routine MDB, electrolyte levels and blood gas estimation should be performed whenever possible.

Plasma lactate levels can be used as a measurement of response to treatment, with an absolute decrease in plasma lactate greater than 40% correlated with increased survival in patients with GDV (Mooney, Raw, & Hughes, 2014). It has also been proposed as having prognostic value in dogs as individuals with a plasma lactate level of < 6 mmol/l on admission have been shown to have a greater chance of survival than those with a plasma lactate of > 6 mmol/l (Green, Tonozzi, Kirby, & Rudloff, 2011).

A complete blood count (haematology) and serum biochemistry are useful to complete the clinical work-up and may help to identify comorbidities. An assessment of coagulation, including, for example, prothrombin and activated partial thromboplastin time in addition to a platelet count, can be useful in cases where DIC is a consideration. Although these results can be useful in the acute setting, and may influence both veterinary and owner decisions, they do not change the need for emergency surgical intervention for patients with GDV.

Abdominal ultrasound/A-FAST (focused assessment with sonography for trauma)

Abdominal ultrasound may be useful to assess for the presence of free abdominal fluid or other negative prognostic indicators; for example, abdominal neoplasia or splenic torsion in the non-trauma patient (McMurray, Boysen, & Chalhoub, 2016).

Radiography

A right lateral abdominal radiograph is indicated to distinguish GD from GDV. In normal dogs, the pylorus is situated in the cranio-ventral abdomen on the right lateral projection. However, with GDV, the pylorus moves away from this position, fills with gas, migrates dorsally and is visible on a right lateral view as an apparently separate compartment in close association with the dilated stomach. This is known as the "reverse C" or "double bubble" sign (**Figure 2**).

In some cases, additional radiographic views may be useful. Radiography can be used to assess for megaoesophagus, aspiration pneumonia, concurrent cardiac enlargement or pulmonary metastatic disease, all of which may affect the patient's prognosis. Some clinicians recommend taking orthogonal views for this purpose, but this may not always be possible in the emergency setting.

Patient stabilisation: from admission to surgery

Fluids

The administration of intravenous (IV) fluids plays an integral part in patient stabilisation. Two large-gauge (14–18 G) IV catheters should be placed in the cephalic veins. The saphenous veins are not used because of the obstruction to venous return by the gastric dilatation.

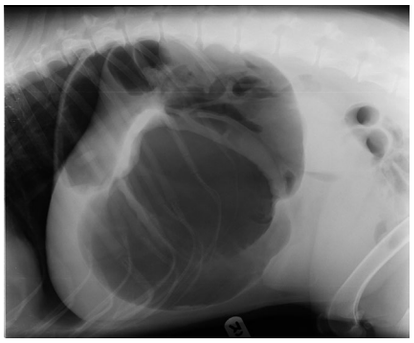

Figure 2. A right lateral abdominal radiograph showing the "reverse C" or "double bubble" sign consistent with a diagnosis of GDV
Credit: © Elizabeth M. Welsh

Fluid therapy should always be administered based on the findings on clinical examination, in addition to any further information collected during patient monitoring for example mean arterial blood pressure. In general, a balanced electrolyte solution (BES) such as lactated Ringer's solution (Hartmann's) tends to be used for initial and ongoing fluid resuscitation (Davis et al., 2013). This can be used at traditional shock doses of 60–90 ml/kg IV for the first hour of treatment. The use of fluid pumps or pressure cuffs is recommended (**Figure 3**).

It is imperative that the patient is closely monitored while fluids are administered. This should include heart rate, pulse quality, CRT, mentation and blood pressure. These should be measured and recorded every 5–10 min, and the fluid rate adjusted under veterinary supervision according to the clinical response.

A recent article has suggested that it may be more appropriate to give crystalloids in 20 ml/kg IV boluses over a 15-min period, assessing the patient's cardiovascular status and adjusting fluid therapy as necessary (Donnelly & Lewis, 2015). Hypertonic saline and colloids may also be used for vascular volume expansion in patients with GDV, although they are

Figure 3. A pressure infusion bag in place around a bag of a balanced electrolyte solution; this allows rapid infusion of a large volume of fluid in large and giant breed dogs. Also visible are intravenous infusion pumps
Credit: © Elizabeth M. Welsh

most commonly used in association with BESs (Holt & Brown, 2007).

Pain relief

An appropriate analgesic such as methadone may be administered IV for pain relief. In many patients this will also provide a degree of sedation. The use of non-steroidal anti-inflammatory drugs (NSAIDs) for analgesia in patients presenting in shock, and those with gastrointestinal disease, should be avoided. If the patient will tolerate it, supplemental oxygen should be given using either a face mask or using a flow-by technique.

Decompression

In right lateral recumbency, and ideally under general anaesthesia (with a cuffed endotracheal tube in place to protect the airway), a lubricated orogastric tube is passed to relieve the gastric distension. The tube should be pre-measured from the nares to the last rib and then marked with tape or an indelible marker to identify the measured length. It is important to remember two things: firstly, being able to pass the tube into the stomach does not indicate that the patient is suffering from GD alone; secondly, it may not always be possible to manipulate the tube into the gastric lumen in cases of GDV. In the latter situation it is important that the tube is not forced forward as this can cause oesophageal or gastric trauma.

In cases where gastric lavage is indicated, a second, smaller-diameter, pre-measured orogastric tube may be placed alongside the initial tube (**Figure 4**). This allows warm fluid for gavage to be instilled into the stomach while the larger tube allows the fluid and gastric contents to drain simultaneously. There are commercially available so-called double lumen tubes.

Figure 4. Two orogastric tubes have been used in this patient with GDV
Note: The patient is anaesthetised, with an endotracheal tube in place. Warm fluid for gavage is introduced into the stomach through the smaller tube while the larger allows gastric contents to be drained simultaneously
Credit: © Elizabeth M. Welsh

In conscious patients undergoing orogastric intubation, sternal recumbency may be tolerated better. In this case the orogastric tube is passed through a rigid tube to act as a gag and secured in the mouth with either a soft fabric muzzle or tape around the patient's nose (**Figure 5**). If the patient's gag reflex is so diminished as to allow this technique, then it may be considered safer to anaesthetise the patient.

Alternatively, a trochar can be used to relieve distension of the stomach. A large-gauge IV catheter or needle may be used as a trochar for this purpose (**Box 1**). It is inserted into the area of maximal tympany, usually in the left cranio-dorsal abdomen (**Figure 6**). The chosen site should be clipped and aseptically prepared before placing the trochar. Success is confirmed by the hissing sound of gas escaping from the stomach.

Figure 5. In conscious patients the orogastric tube may be introduced through a mouth gag secured with a fabric muzzle
Credit: © Elizabeth M. Welsh

Figure 6. Orogastric intubation was initially unsuccessful in this Dogue de Bordeaux Trocharisation of the stomach at the point of maximal tympany (in this case on the right) allowed gastric decompression and subsequently an orogastric tube was passed successfully
Credit: © Elizabeth M. Welsh

Box 1. Equipment required for trocharisation

- clippers
- materials for aseptic surgical preparation of the proposed site
- sterile gloves
- hypodermic needle/over-the-needle catheter of suitable size, for example 12–14 G

Gastric and splenic lacerations are risks when using this technique, and to this end, if the patient starts to struggle during this procedure, the trochar should be removed immediately. Relieving gas distention of the stomach using this technique may allow subsequent placement of an orogastric tube even if this was previously impossible. A recent study found that neither technique was associated with increased survival in patients with GDV (Goodrich, Powell, & Hulting, 2012), although the authors concluded that trocharisation may be more desirable in unstable patients as it does not require a full general anaesthetic.

Monitoring

It is important to monitor the patient closely during stabilisation and record changes in the heart rate, pulse rate and quality, CRT and mucous membrane colour, respiratory rate and mentation to allow the effectiveness of the interventions undertaken to be assessed. The use of a multi-parameter monitor (when one is available) is warranted in these patients, as it provides additional methods of monitoring these critical patients, for example ECG, blood pressure (direct/indirect), SpO_2.

Conclusion

Prompt diagnosis and appropriate stabilisation are intrinsic to the successful management of patients with GDV. In the next article, the intra- and post-operative care of the GDV patient will be discussed.

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Multiple Choice Questions

1. Which of the following is FALSE regarding orogastric tubes?

(a) They are useful for the relief of gastric distension

(b) They can distinguish distension from distension with volvulus

(c) They should be lubricated and measured from the nares to the last rib

(d) They are useful for gastric lavage

2. Plasma lactate levels:

(a) Are diagnostic for GDV if >6 mmol/L

(b) Contribute to metabolic alkalosis

(c) Are a useful prognostic indicator

(d) Can increase by up to 40%

3. What type of shock is associated with the physiology of a GDV?

(a) Cardiogenic

(b) Distributive

(c) Hypovolaemic

(d) All of the above

4. What radiographic feature confirms your diagnosis of GDV?

(a) Poor serosal detail

(b) Large gas filled hollow organ

(c) The reverse C sign

(d) Twisting of the oesophagus

5. What is true of the surgical procedure?

(a) Gastric tissue necrosis is associated with poorer outcomes

(b) Splenectomy should be routinely performed at the time of the volvulus correction and gastropexy

(c) Decompression by orogastric tube or trocharisation pre-operatively increases the chance of survival

(d) Splenectomies are associated with more positive outcomes

6. IV fluids are critical in the treatment of GD/GDV patients and response should be monitored every 5 minutes. Traditionally shock rate fluids are given initially, but recent work suggests:

(a) Colloids given at 20 mL/kg over 15 minutes

(b) Hypertonic saline

(c) Crystalloids given at 60-90 mL/kg for first hour

(d) Crystalloids given at 20 mL/kg over 15 minutes

7. Trochars should:

(a) Be used in patients who are relatively still due to the risk of gastric or splenic lacerations

(b) Improve the chance of passing an orogastric tube, even if previously not possible

(c) Be placed in the area of minimum tympany while the patient is in right lateral recumbency

(d) Be more useful than orogastric tubes because a full GA is not necessary

For the answers to the MCQs, please go to: http://www.bvna.org.uk/publications/veterinary-nursing-journal