GASTRIC DILATATION VOLVULUS:
FROM TRIAGE TO DISCHARGE

Elisa M. Mazzaferro, MS, DVM, PhD, DACVECC
Oliver D.E. Morgan VMD, DACVS
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Incidence of GDV

Risk Factors
- Large or giant breed dogs
- Pure bred dog (8.6 to 1)
- Advancing age
- Hepatosplenic ligament length
- Physical conformation
- Temperament
- Reduced thoracic width:depth ratio
- Height
- Splenectomy
- Gastric foreign body

Other Implicating Factors
- Gastrin
- Myoelectric dysfunction
- Increased LES sphincter pressure
- Delayed gastric emptying
- Aerophagia
- Esophageal motility disorders
- Feeding practices

Gastric Dilatation-Volvulus
- First reported in 1906 in dogs
- Also known as:
  - Bloat
  - Gastric torsion
  - Torsion
  - Gastric dilatation
  - GDV

What Can We Do?

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  - GDV
Can We Change The Food?
- Smaller food particles increases risk?
- Dry food that contains oil or fat listed as 1st 4 ingredients
- Feeding one single food alone?
- Feed multiple smaller meals may decrease risk
- Feeding dry with fish or eggs may decrease risk

Feeding Practices?
- Feeding one single food alone?
- Feed multiple smaller meals may decrease risk
- Raising the food bowl?
  - Actually increased risk of GDV

Environmental Factors
- Recent kenneling or car ride
- Stress/agitation
- Increased atmospheric pressure
- More than 50% November to January (TX)

Can We Prevent?

Presenting Complaints
- Retching or unproductive vomiting
- Lethargy
- Swollen or distended abdomen
- Restlessness
- Pytalism
- Straining to defecate
- Grunting or moaning
- Recumbancy

Physical Examination
- Pale mucous membranes
- Labored breathing
- Retching
- Distended tympanic abdomen
- Tachyardia with bounding or weak pulses
- Irregular heart rhythm
Treatment Guidelines
- Gastric decompression
- Restore preload
- Improve organ perfusion
- Decrease lactic acidosis
- Treat dysrhythmias

Consequences of GDV
- Hemodynamic Effects
  - Decreased venous return
  - Decreased cardiac preload
  - Decreased cardiac output
  - Hypotension

Consequences of Decreased Cardiac Output
- Hypotension
- Inadequate diastolic filling
- Coronary artery hypoperfusion
- Myocardial hypoxemia and acidosis
- Arrhythmias
- Further decline of cardiac output

Cardiac Output
\[ Q = \text{Heart Rate} \times \text{Stroke Volume} \]
- Preload
- Afterload
- Contractility
- Dysrhythmias
  - Tachycardia
  - Bradycardia
- Decreased venous return

Inflammatory cytokines
- Myocardial depressant factor
- Lactic acidosis

Intravenous Catheter
- 90 ml/kg/hour IV
- Start with ¼ of calculated volume
- Constant reassessment of perfusion parameters
  - Heart rate
  - Blood pressure
  - Mucous membrane color and CRT

Fluid Therapy
Colloids

Colloids

5–10 ml/kg bolus

What About the Bloat Bucket?!?!

Two buckets

Orogastric tube(s)

Pump

Passing the Orogastric Tube

Mark the tube

Measure from tip of mouth to last rib

Passing the Orogastric Tube

Secure roll of two inch tape in mouth and around muzzle

Passing the Orogastric Tube

Lubricate tip of tube and pass through the middle of the tape roll

Passing the Orogastric Tube

Gastric Lavage

Look for necrotic mucosa
Ausculting the Abdomen

Percuss and listen for most tympanic area

Trocharization

Clip and scrub over most tympanic area

Trocharization

Tent skin and slowly introduce large bore over-the-needle catheter

Trocharization

Advance needle off of catheter and allow air and fluid to flow... Stand back!

The Electrocardiogram

Sinus Tachycardia

Ventricular Premature Contractions (VPC’s)
**Electrocardiogram**

- Multiform VPC’s

**Cardiac Dysrhythmias**

- Indications for treating ventricular dysrhythmias
  - Prolonged ventricular tachycardia > 160/min
  - Multiform ventricular tachycardia
  - “R on T” or ventricular flutter
  - Anesthesia

**Treatment of Dysrhythmias**

- Lidocaine
  - 1 – 3 mg/kg IV
  - IV CRI 50 – 100 mcg/kg/min
- Crystalloid bolus
  - 5 – 10 ml/kg
- Supplemental oxygen

**Arterial Blood Pressure**

**Analgesia**

- Buprenorphine (0.005 – 0.02 mg/kg IM or IV)
- Fentanyl 2 mcg/kg IV bolus
- Avoid morphine and hydromorphone due to potent emetic effects
**Diagnostics**

- Minimum data base
- PT/APTT
- Venous lactate
- Electrolytes
- Blood pressure
- ECG
- Radiographs

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**Venous Lactate**

> 6.0, 7.4 mmol/L increases risk of mortality

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**Venous Lactate**

<table>
<thead>
<tr>
<th>References</th>
<th>Gastric Necrosis</th>
<th>No Gastric Necrosis</th>
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</thead>
<tbody>
<tr>
<td>de Popp et al. (^a)</td>
<td>6.6 (6.8-10.9)</td>
<td>3.2 (2.1-14.4)</td>
</tr>
<tr>
<td>Greer et al. (^b)</td>
<td>6.35 (1.0-10.9)</td>
<td>3.4 (0.7-14.8)</td>
</tr>
<tr>
<td>Szamaro Brey et al. (^c)</td>
<td>6.05 (1.0-14.4)</td>
<td>4.5 (0.8-15)</td>
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</tbody>
</table>

* Range calculated from original data.

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**Radiographs**

- Right lateral abdomen

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**Venous Lactate**

<table>
<thead>
<tr>
<th>Initial, Final, and Changes in Plasma Lactate Concentration in Surviving and Non-surviving Dogs with GDV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survivors, n = 49</td>
</tr>
<tr>
<td>Initial lactate concentration (mmol/L)</td>
</tr>
<tr>
<td>Final lactate concentration (mmol/L)</td>
</tr>
<tr>
<td>Absolute change in lactate concentration (mmol/L)</td>
</tr>
<tr>
<td>Percentage change in lactate concentration (%)</td>
</tr>
</tbody>
</table>
GASTIC DILATATION-VOLVULUS

Unusual GDV

Food Bloat

LOOK FOR PNEUMATOSIS

Prognosis with Gastric Necrosis

<table>
<thead>
<tr>
<th>Reference</th>
<th>Number of Cases</th>
<th>Survival</th>
<th>Necrosis</th>
<th>Herniation</th>
<th>Acute perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>20/30</td>
<td>10/30</td>
<td>20/30</td>
<td>10/30</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>40/50</td>
<td>15/50</td>
<td>35/50</td>
<td>15/50</td>
</tr>
</tbody>
</table>

Thoracic Radiographs
Anesthesia

- Reasons for administering premedication
  - Decrease anxiety
  - Provide analgesia
  - Decrease total induction and maintenance anesthetic doses
  - Attempt to minimize cardiovascular depression

Balanced Anesthesia

- Opioid + Benzodiazepene ± Etomidate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Fentanyl</td>
<td>5-10 mcg/kg IV</td>
</tr>
<tr>
<td>Midazolam</td>
<td>0.2-0.5 mg/kg IV</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.4 mg/kg IV</td>
</tr>
<tr>
<td>Etomidate</td>
<td>0.5 – 1.0 mg/kg IV</td>
</tr>
</tbody>
</table>

Anesthetic Agents to Avoid

- Phenothiazine tranquilizers
  - α-blockage causes peripheral vasodilation
- Alpha-2 Agonists
  - Decreased CO and hypotension
- Propofol
  - Vasodilation
- Ketamine
  - Direct myocardial depression in most critical patients

Maintaining Blood Pressure

- Avoid fluid loss
- Crystalloid and colloid boluses
- Use of inotropic agents
- Use balanced anesthesia
- Use of pressor agents

Anesthetic Monitoring

- Electrocardiogram
- Blood Pressure
- Pulse oximetry
- End-tidal CO₂

Decrease Anesthetic Depth
- CRI Fentanyl
  - Mechanical ventilation

Inotropes
  - Dopamine
  - Dobutamine
  - Ephedrine

Fluid Balance
  - Crystalloids
  - Colloids
  - Blood
  - Oxyhemoglobin

Control Dysrhythmias
  - Lidocaine

Pressors
  - Epinephrine
  - Norepinephrine

BLOOD PRESSURE
Gastric Dilatation Volvulus From Triage to Discharge

Oliver D. E. Morgan, VMD, DACVS
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Surgery
- As soon as patient is stabilized as best as possible
  - Patient may still be very unstable
- Plan:
  - Correct gastric malpositioning
  - Assess/treat gastric and splenic ischemic injury
  - Deal with and stop hemorrhage
    - Typically from short gastric arteries
    - Prevent recurrence with a gastropexy

Surgery: Exploratory
- Ventral midline laparotomy
  - If twisted, stomach is found as soon as you enter the abdomen covered by the greater omentum ventrally
  - Intra-op needle gastrocentesis will facilitate visualization and repositioning
    - Perform prior to placing Balfour and prior to attempting to pass orogastric tube
    - Once significantly decompressed then pass orogastric tube
  - Hemoabdomen
    - Rupture of the short gastric arteries

Surgery: Gastric derotation
- Usually 180 degree and clockwise twist:
  - Grasp pylorus with one hand on the left side of the body and stomach on the right side with other hand
  - Push down on the right and pull pylorus up
  - Gently untwist stomach by moving it from a left to ventral to right direction
  - Aided significantly by completely decompressing first

Surgery: Gastric viability
- Gastric necrosis most common along the greater curvature at the fundus
- Evaluation
  - Red
  - Purple
  - Gray-green
  - Black
  - Thinning
  - Torn
Surgery: Gastric resection

- Gastric compromise near the cardia is technically demanding to resect
  - Placement of an orogastric tube can help plan stomach resection
- Resect full thickness stomach wall until bleeding tissue is encountered
- Closure is done in two layers
  - mucosa and submucosa
  - muscularis and serosa

Surgery: Partial gastrectomy

- Pre-place stay sutures
- Cut and inspect edges for bleeding
- Absorbable monofilament suture
- Simple continuous first layer
- Simple interrupted or continuous inverting pattern second layer
- Do not invaginate the necrotic or devitalized stomach
- Place gastric tube to decompress stomach postsurgically

Surgery: Splenic viability

- After gastric derotation, evaluate spleen in its normal position
- Examine splenic vessels for arterial thrombosis and absence of pulses
  - If twisted, do not untwist prior to removal
  - If questionable, perform splenectomy

Surgery: Partial gastrectomy

- Other techniques
  - Surgical staples
    - GIA-50
    - TA-90
    - staple line should overlap and be oversewn
  - Invagination – not recommended
    - invert and sew over necrotic tissue by apposing healthy serosa
    - necrotic portion of stomach will be digested and can create ulcer and bleeding

Surgery: Splenectomy

- Surgical staples
- Ligature techniques
- Vessel sealing devices dramatically decrease surgical time
  - Can cauterize, coagulate, and divide vessels up to 7mm
Surgery: Gastropexy

- Commonly used techniques
  - Incisional
  - Tube gastropexy
  - Circumcostal
  - Belt-loop
  - Incorporating – DO NOT PERFORM
- Other reported techniques
  - Fundic gastropexy
  - Gastrocolopexy—recurrence rate higher than with other techniques (20% vs 4% for circumcostal)
  - Percutaneous Gastrostomy—weak, not recommended

Incisional Gastropexy

- Simple and fast
- A 4-5 cm seromuscular incision is made in the pyloric antrum
- Matching incision made through peritoneum and transverse abdominus muscle 3cm caudal to 13th rib
- Suture edges craniodorsally dorsal to ventral, then caudoventrally dorsal to ventral and tie to one another

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**GASTIC DILATATION-VOLVULUS**

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**Tube Gastropexy**
- Easy to perform
- Provides enteral access
- Provides means for decompression post-op
- 20 Fr. Tube for big dogs
- Mila tube is great tube and helps prevent dislodgement
- Surgically tacked to body wall in box

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**Belt-Loop Gastropexy**
- Seromuscular flap made in pyloric antrum which has a central branch of the right gastroepiplic artery at its base
- A belt-loop of transversus abdominus muscle is created 3-4 cm caudally to the costal arch and ~1/3 of the distance from the ventral to dorsal midline. Two parallel incisions (~2.5 cm long and 2.5 cm apart) are made through parietal peritoneum and transversus abdominus fascia

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**Circumcostal Gastropexy**
- Flap of serosa/muscularis created on stomach
- Passed around the 13th rib
- Sutured back to stomach
- Strong
- Annoying to perform
- Unnecessary security

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**What Should I Anticipate Post-Op?**
- Ventricular dysrhythmias
- Gastrointestinal hypomotility
- Electrolyte imbalances
  - Hypokalemia
- Systemic Inflammatory Response (SIRS)
- DIC

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**Post-op Complications**
- Aspiration pneumonia
- Gastritis
- Peritonitis/Sepsis
- Reperfusion Injury
- Disseminated Intravascular Coagulation (DIC)
- Thromboembolic disease (PTE)
- Systemic Inflammatory Response Syndrome (SIRS)
- Multiple Organ Dysfunction Syndrome (MODS)
- Acute Lung Injury (ALI)
- Acute Respiratory Distress Syndrome (ARDS)
**Postoperative Management**

- Most important part of management of GDV
- Patients should be monitored 24 hours a day following GDV surgery
- Vital signs
  - Heart rate, rhythm, pulse quality
  - Mucous membrane color, perfusion
  - Urine output
  - Body temperature
  - Weight

**Postoperative Management**

- Analgesia
  - Opioids – fentanyl CRI, buprenorphine
  - Gastric protectants
  - H₂ blockers
  - Acid pump inhibitors
- Feeding
  - Start after 24-48 hours
  - Consider gastric motility enhancers
    - Metoclopramide 1-2 mg/kg/day
  - Nursing care
  - 24 hour monitoring for 1-2 days

**Post-Op Treatment and Monitoring**

- Fluid Balance
  - 2.2 ml/kg/hour
  - +/- 20 – 30 ml/kg/day colloid support
  - +/- urine output
  - +/- Measure and record volume of emesis or nasogastric suctioning

- Hypomotility
  - Myoelectric activity impaired for 48-72h post-op
  - Metoclopramide CRI
    - 1-2 mg/kg/day IV CRI
  - Use lowest dose of opioid necessary to maintain adequate analgesia
  - Lidocaine
  - Gastric suctioning

**Post-Op Treatment and Monitoring**

- Ventricular Dysrhythmias
  - Lidocaine CRI 30 mcg/kg/min, increase dose to 100 mcg/kg/min as necessary
  - Treat if V-tach > 160 bpm, R on T, or multiform

**Post-Op Treatment and Monitoring**

- Procainamide
  - 10-15 mg/kg IV, then 25-50 mcg/kg/min CRI
  - 10 – 20 mg/kg PO QID
  - WATCH POTASSIUM AND MAGNESIUM!
GASTIC DILATATION-VOLVULUS

**Analgesia Post-Op**
- Adequate analgesia is paramount
  - Fentanyl CRI
    - 2 – 7 mcg/kg/hour
  - Lidocaine CRI (analgesia and rhythm control)
    - 15 – 30 mcg/kg/min
  - Morphine CRI
    - 0.1 mg/kg/hour or 0.2 – 0.5 mg/kg IM or SQ
    - Buprenorphine
      - 0.01-0.015 mg/kg IV or IM

**Post-Op Treatment and Monitoring**
- Systemic Inflammatory Response Syndrome (SIRS)
  - Temperature < 100°F or > 103.5°F
  - Respiratory Rate > 20 breaths/min
  - $P_aCO_2$ < 32 mm Hg
  - Heart rate > 160 bpm
  - WBC < 4,000 or > 12,000, > 10% bands

**Post-Op Treatment and Monitoring**
- Disseminated Intravascular Coagulation
  - Daily platelet counts and coagulation tests
    - APTT/PT
    - FDP's or D-dimers
    - Antithrombin levels

**Post-Op Treatment and Monitoring**
- Nasogastric suctioning
  - Required for refractory hypomotility
  - Can develop hypochloremic metabolic alkalosis
  - Keep track of amount lost so you can replace!

**Prognosis**
- Overall mortality rate is 15-30%
  - Without gastric necrosis-2%
  - With gastric necrosis-34-46%
  - Gastric necrosis and surgery where partial gastrectomy with or without splenectomy are performed have mortality rates of 55% and 32%
  - Cardiac arrhythmias occur in ~ 40% of dogs with GDV (may or may not be associated with outcome)

**Prognosis**
- Preoperative plasma lactate concentrations > 6 mmol/L are predictive of gastric necrosis and thus a more guarded prognosis
  - Lactate < 6 mmol/L 99% survival
  - Lactate > 6 mmol/L 56% survival
  - Lactate >7.4 mmol/L 82% accurate predictor of gastric necrosis
  - Lactate >7.4 mmol/L 88% accurate predictor of outcome
  - Gastropexy is effective at preventing recurrence
    - recurrence rate with gastropexy: 4%
    - recurrence rate without gastropexy: 42-72%
    - Overall survival ~85%
**Recommendations to Owners**

- Do not breed dogs with first-degree relatives that have history of bloat or GDV
- Feed several small meals a day, do not raise food bowl
- Avoid stress and activity around meal time
- Educate owners on the clinical signs of GDV
- Strongly consider prophylactic gastropexy in high-risk dogs
  - Laparoscopic or laparoscopic-assisted minimizes morbidity
  - Gastropexy at time of spay
- Strongly recommend for Great Dane, German Shepherds, giant breeds, deep chested breeds

**Laparoscopic-assisted Gastropexy**

- Minimally invasive
- Can be performed in conjunction with spay or neuter
- Minimize morbidity
- Fast recovery
- Decreased infection rates
- Small incisions

**Take Home Points**

- Emergency stabilization and post-operative care/monitoring are the keys to a successful outcome.
- Permanent gastropexy should always be performed in conjunction with exploratory laparotomy of GDV patients.
- Veterinarians should be comfortable with the surgical techniques of gastric resection, splenectomy and gastropexy if managing GDV.