Small Animal Abdominal Radiography
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Lecture Outline

• Radiographic technique
• Introduction to systematic review and principles of interpretation
• Basic abdominal radiographic anatomy

Radiographic Positioning

• Multiple projections should **always** be obtained
  • 2-D image of 3-D structures → Superimposition, Summa. on, and Silhouetting of structures
  • Obtain at least 2 orthogonal (90°) views
  • Important for lesion localization
  • Additional projections can be helpful
Radiographic Positioning

• For the abdomen, typically 2 projections obtained
  • Ventrodorsal (VD)
  • Lateral projection – Left (preferred) or Right (GDV) Lateral

• Remember – Projections named for the direction of the x-ray beam through the patient to the film
  • Ventrodorsal: Dorsal recumbency
  • Dorsoventral: Sternal recumbency
  • Right lateral (Left-Right lateral): Right side down
  • Left lateral (Right-Left lateral): Left side down

Radiographic Positioning

• Include the entire abdomen
  • Cranial extent: Diaphragm
  • Caudal extent: Greater trochanter
  • Large dogs: May not fit on a single radiograph
    • Radiograph the cranial and caudal aspects separately for each view

Radiographic Projection

• Projection obtained at maximal (end) expiration
• Less superimposition of structures
• Longer respiratory pause
  • Goal: Take the radiograph with no movement

  versus Thoracic radiographs
  • Obtained at maximal (peak) inspiration
Positioning Aids

- Sandbags
- Foam blocks or wedges
- Sedation

- Troughs
- Tape
- Rope

Radiographic Positioning

- Proper positioning is important!
  - Aids in recognition of normal versus pathology

Poor radiographs are at best inconclusive and at worst misleading.

So now you have a radiograph...

- Confirm appropriate positioning and technique
  - Entire abdomen included
  - Patient is straight
  - VD/DV: Dorsal spinous process on midline superimposed over the vertebrae
  - Lateral: Transverse processes, ilium, and rib heads superimposed
So now you have a radiograph...

- Check for artifacts
  - Positioning aids, Markers, IV tubes, ECG wires, Collars, etc.
  - Wet hair
  - Motion

Possible Search Methods

- Organ systems
  - Body condition → Structures outside of the abdomen → Abdominal wall → Serosal detail, Peritoneal and retroperitoneal spaces → Liver → Spleen → Kidneys → Urinary bladder → (Prostate, Uterus) → Gastrointestinal tract

Be Consistent

Dog
Possible Search Methods

- Organ systems
  - Body condition → Structures outside of the abdomen → Abdominal wall → Serosal detail, Peritoneal and retroperitoneal spaces → Liver (&GB) → Spleen → Kidney → Urinary bladder → (Prostate, Uterus)

**Be Consistent**

Systematic Approach

Describe the radiographic signs (any changes or abnormalities)
- Roentgen signs
- Radiographic opacities
  - Skipping this step and going straight to a diagnosis may lead to misdiagnosis!

Establish a "Radiographic diagnosis"

Make a list of differential diagnoses

Factors Affecting Visualization of Abdominal Organs

- Projection
- Differences in radiopacity
- Normal variations
Factors Affecting Visualization of Abdominal Organs

• Projection
  - Structures closer to the detector better evaluated
  - Changes in position of gas and fluid
  - Gas goes up, fluid goes down
  - Alterations from interventions and disease

• Differences in radiopacity
  - Most abdominal organs are soft tissue opacity → Low subject contrast between structures in the abdomen

Factors Affecting Visualization of Abdominal Organs

• Differences in radiopacity
  - Abdominal and retroperitoneal fat prevents silhouetting of adjacent soft tissue structures → Increased

Factors Affecting Visualization of Abdominal Organs

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Factors Affecting Visualization of Abdominal Organs

- Fat Content
  - Obese
  - Good subject contrast
  - Emaciated
  - Very poor subject contrast

• Normal variations
  • In SIZE
    - Stomach, colon, urinary bladder
    - Canine: Spleen
  • In CONTENT
    - Of the GI tract: Gas, fluid, food, feces
  • Body conformation
  • Species, breed
  • Body condition
  • Respiratory phase

Interpreting the Radiograph
Abdomen

Dog

Abdomen as a Whole

• Body condition
  • Affects subject contrast and therefore visualization of organs

• Abdominal wall
  • Abdominal distension
  • Body wall defects

Abdomen as a Whole

• Peritoneum
  • Serosal detail

• Retroperitoneum
  • Demarcated ventrally by the parietal peritoneum & dorsally by the sublumbar musculature
  • Extends caudally to the pelvic inlet
  • Kidneys, ureters, adrenal glands, aorta, caudal vena cava, sublumbar lymph nodes cisterna chyli
Serosal Detail

- The ability to see the serosal margins of abdominal viscera due to the presence of outlining fat
- Alterations may be focal or diffuse

Causes of decreased serosal detail
- Poor technique – Underexposure
- Immaturity
  - Young dogs and cats due to “brown” fat
- Lack of abdominal fat
  - Thin or poor body condition, Emaciation, Cachexia
  - Peritoneal effusion (any type of fluid)
- Mass effect
  - Mass or enlarged structure results in displacement and silhouetting of adjacent organs
- Peritonitis
- Carcinomatosis
Serosal Detail
• Mottled serosal detail
  • "Ground-glass" appearance
  • Differential diagnoses:
    • Peritonitis
    • Carcinomatosis

Serosal Detail
• Increased Serosal Detail (free abdominal gas)
  • Differential diagnoses:
    • Perforated Intestine
    • Gas-Producing Bacteria
    • Penetrating Wound
    • Recent Laparotomy

8 year old Germ Shep
PC: abdominal distension and retching

Intestinal Perforation
Abdominal Organs

- Visible organs
  - Gastrointestinal tract
    - Portions of the stomach, small intestines, and large intestine
  - Liver
    - Ventral and caudal ventral margins
  - Spleen
    - Especially in dogs
  - Kidneys
    - In dogs, especially the left
  - Urinary bladder
  - Prostate (Intact male dogs)

Abdominal Organs

- Not routinely visualized
  - Gallbladder
  - Pancreas
    - Sometimes seen in fat cats on VD projection
  - Lymph nodes
  - Adrenal glands
  - Ovaries
  - Uterus
  - Prostate (Cats or neutered dogs)

Gastrointestinal Tract

- Stomach
- Small intestines
- Colon
GI Tract - Stomach

- Cardia and Fundus
  - Left craniodorsal abdomen
  - Caudal to the left diaphragmatic crus
- Body
  - Ventral
- Pyloric antrum (canal)
  - Right ventrolateral abdomen

- Appearance depends on
  - Radiographic projection
  - Species and Body conformation
  - Gastric contents

- Radiographic projection
  - Location of the gas and fluid changes with patient position
    - Anatomy
    - Gravity: Gas goes up, Fluid goes down
    - Can help identify the projection
Right Lateral Radiograph

Fluid in Antrum
Gas in Fundus

Left Lateral Radiograph

Fluid in Fundus
Gas in Antrum

VD

Verus VD

Gas in Fundus
Fluid in body

Gas in body (+/- antrum)
Fluid in Fundus & Antrum
GI Tract - Stomach

• Species - Cats
  • VD/DV projection:
    • "J" shaped
    • The pyloric antrum is on or slightly to the right of midline on the VD/DV

Gi Tract - Stomach

• Gastric axis
  • Line from the fundus to the antrum
    • Lateral view: Perpendicular to the spine or parallel to the ribs
    • VD/DV: Perpendicular to the spine

Gi Tract - Stomach

• Body conformation – Dogs
  • Gastric axis
    • Barrel-chested breeds: Parallel with the ribs
    • Deep-chested breeds: Perpendicular to the spine
GI Tract - Stomach

• Gastric contents
• Type
• Volume (degree of gastric distension)
  * Unless distended, it is normally within the costal arch (rib cage margin) and does not project caudal to the last ribs.

8 year old Germ Shep
PC: abdominal distension and retching

Gastric Dilatation
and Volvulus with
Gastric Pneumatosis

8 year old Germ Shep
PC: abdominal distension and retching
Feline GDV

Guinea Pig GDV

8 year old Labradoodle
Vomiting and Inappetance
Gastric Outflow Obstruction – Fruit Pit
GI – Small Intestines

- Duodenum
  - Right-sided
    - Proximally is against the caudal surface of the liver
    - Descending duodenum courses parallel to the body wall
  - Dogs: Lateral, adjacent to the body wall
  - Cats: More medial course than dogs

- Jejunum & Ileum
  - Variable position in the mid abdomen
  - Distribution depends on:
    - Body conformation
    - Size, shape, and position of adjacent viscera
    - Diaphragm and mesentery displacement

What projection → ???
GI – Small Intestines

- Obese dogs and cats
  - Intraluminal fat tends to displace SI into the central midabdomen
  - In obese cats, most located in the right mid-abdomen

Intraperitoneal Lipoma

13 year Lab PC abdominal distension

GI Tract – Small Intestines

**Duodenum - Jejunum - Ileum**

- Contains variable amounts of intraluminal gas
- Cats have less intraluminal gas
- Peristalsis
- Cats: “String of pearls”

What projection → ???
Gi Tract – Small Intestines
Duodenum - Jejunum - Ileum

• Maximal Diameter (serosa to serosa)
  • Dogs:
    • ≤1.6x the height of L5 at the midbody (narrowest)
    • ≤2x the width of a rib
    • ≤ width of an intercostal space

*The lateral projection is used to evaluate vertebral body height

Duodenum - Jejunum - Ileum

• Maximal Diameter (serosa to serosa)
  • Cats:
    • ≤2x the height of L4 at the midbody
    • ≤2x the height of the cranial L2 endplate
    • ≤12 mm (US)

*The lateral projection is used to evaluate vertebral body height

Duodenum - Jejunum - Ileum

• Maximal Diameter (serosa to serosa)
  • Similar in diameter to each other
    • Abnormal if >1.5 – 2x (50-100%) larger than other segments = “Two populations”
      (little/normal ones & big ones)
    • (Duodenum may normally be mildly larger than other segments)
7/30/2018 58
3 year old DSHA
PC: Vomiting

7/30/2018 59
4 year old Mixed Breed
PC: Vomiting
Linear foreign body anchored in the stomach

7/30/2018 60
3 Year Old Pitbull
PC: Vomiting
8 year old Germ Shep
PC: Vomiting, abdominal pain, recumbent

Mesenteric Torsion

http://www.fmnu.utl.pt

Gi Tract – Large Intestines

- Cecum (c): Right mid, Level of L3
  - Dogs: “cork-screw” or “C” shaped
  - Cats: Small, Not usually visible
- Ascending colon (a): Right mid to cranial
- Transverse colon (t): Caudal to stomach
- Descending colon (d): Left
- Rectum (r): Pelvic canal and caudal
3 year old Jack Russel Terrier
PC: vomiting and inappetance. Recently ate a cow bone

Post Pneumocolonogram
Mineral material within the ileum
7yo Lab
Straining to defecate and pacing
Liver

- Cranial abdomen
  - Caudal to and conforms to the diaphragm
- Caudoventral margin:
  - Right lateral view: Right medial lobe
  - Left lateral view: Left lateral lobe
Liver

- Assessment:
  - Does not extend caudal to the costal arch
  - Sharp caudoventral margins (not rounded)
  - Normal gastric axis - // to ribs or ⊥ to spine
Liver

• Assessment:
  • Gastric axis
    • Normal: // to ribs, \ to spine

Liver

• Assessment:
  • Hepatomegaly:
    • Caudal displacement of antrum (gastric axis)
    • Extends caudal to costal arch
    • Rounded margins

Liver

• Assessment:
  • Microhepatica:
    • Cranial displacement of antrum (gastric axis)
Case

• 11 year Mixed Breed
• PC: Vomiting, abdominal pain, clinician is suspicious of sepsis

Hepatic Abscess with Sepsis Peritonitis

Gall bladder

• Right craniocentral abdomen
• Not usually seen
• Cats:
  • When distended, may produce a bulge along the ventral hepatic silhouette
Gall bladder

- Right cranioventral abdomen
- Not usually seen
- Cats:
  - When distended, may produce a bulge along the ventral hepatic silhouette
  - Differential diagnosis: Hepatic nodule or mass

12 year Mixed Small Breed
PC: Lethargy, tachypnea, recent vomiting

Emphysematous Cholecystitis

Spleen

- Flat, elongated
- Dorsal extremity
  - Left, cranial, dorsal, lateral
  - Caudal to the gastric fundus
- Ventral extremity
  - Dogs: Variable
  - Cats: Not seen ventrally on lateral projection
  - Enlarged if seen along ventral abdomen
Spleen
- Flat, elongated
- Dorsal extremity
  - Left, cranial, dorsal, lateral
  - Caudal to the gastric fundus
- Ventral extremity
  - Dogs: Variable
  - Cats: Not seen ventrally on lateral projection
    - Filtered if seen along ventral abdomen

Kidneys
- Retroperitoneal
- Ureters not seen
- More mobile in cats
Kidneys

- Retroperitoneal
- Ureters not seen
- More mobile in cats

**Right kidney:**
- More difficult to visualize
  - Adjacent to & silhouettes with caudate liver lobe
  - Cranial margin:
    - Dog: ~ T13 – L1
    - Cat: ~ L1 – L2

**Left kidney:**
- Cranial margin:
  - Dog: ~ 1 vertebral body caudal to Right kidney
  - Cat: ~ L1 – L3

- Retroperitoneal
- Ureters not seen
- More mobile in cats

**Kidney size:**
- Ratio: Renal length to L2 body length
  - VD projection
  - Dog:
    - 2.5 – 3.5x length of L2
  - Cats:
    - Intact: 2.4 – 3.2x length of L2
    - Neutered: 1.9 – 2.6x length of L2
Kidneys

- Kidney size:
  - Ratio: Renal length to L2 body length
    - VD projection
    - Dog: 2.5 – 3.5x length of L2
    - Cats:
      - Intact: 2.4 – 3.2x length of L2
      - Neutered: 1.9 – 2.6x length of L2

13 year old FS DSH
PC: Vomiting, Anorexia, Azotemia

Renal Lymphoma
Adrenal Glands

- Retroperitoneal
- Cranialmedial to kidney
- Not normally seen
- Cats: Incidental mineralization
  - Dogs: Mineralization associated with neoplasia

13 year old Beagle
PC: Abdominal distension, PU/PD
Urinary Bladder

- Caudal ventral abdomen
- Cranial to pubis
- Ventral to descending colon and rectum

Caudal ventral abdomen
- Round, tear- or pear-shaped
- Variably sized
- Exerts mass effect when large

12yo MN Scottish Terrier
PC: Recurrent urinary tract infections
12yo MN Scottish Terrier
PC: Recurrent urinary tract infections

Transitional Cell Carcinoma

2yo MI Boston Terrier
PC: Straining to Urinate/Defecate with a perineal “mass”

What’s not there?

2yo MI Boston Terrier
PC: Straining to Urinate/Defecate with a perineal “mass”

Perineal hernia with bladder herniation
Prostate

- Caudal abdomen / Cranial pelvic canal
  - Caudal to bladder, Ventral to rectum
  - Not normally seen in cats or neutered dogs

Prostate

- Caudal abdomen / Cranial pelvic canal
  - Caudal to bladder, Ventral to rectum
  - Fat triangle: between body wall (ventral), bladder (caudoventral margin), prostate (cranioventral margin).
  - Not normally seen in cats or neutered dogs

Prostate

- Intact male dogs:
  - Lateral: Length or height as % of Pubic brim to sacral promontory dimension
    - Normal: < 70%
      (mean 50%)
    - VD: < 50% of the pelvic inlet width
Prostatic Mass with Metastatic Disease

Thank You